# SCIENCE

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FRIDAY, SEPTEMBER 5, 1902.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

## *DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES.*

FOR the fifth year we publish statistics in regard to the conferring of the degree of doctor of philosophy by American universities. The figures have been obtained from official sources; they are correct and reasonably complete. Twenty-seven institutions are given on the table, and replies have been received from as many more. Several of our best colleges do not give the degree. This appears to be wise, at least so long as universities such as Kansas, Missouri and Tulane have found occasion to grant it but once in five years, and Stanford and Princeton have on the average granted it but twice a year. The figures published, not very promptly, by the Bureau of Education indicate a larger number of doctorates of philosophy, but these must include institutions that have no right to confer this degree, giving it for work done *in absentia* or perhaps for the payment of a fee. Our record during the past five years shows that the degree has been granted by good institutions to 1,158 candidates, or an average of about 230 each year. This is a considerable number of well-educated men, but after all rather insignificant when compared with the population of the country, or even with the number of teachers employed in our schools. No statistics are available to show

the number of doctorates conferred on Americans by German or other foreign universities, but as our own universities become better equipped the number of students going abroad tends to decrease.

DOCTORATES CONFERRED.

| | 1902 | 1901 | 1900 | 1899 | 1898 | Total |
|---|---|---|---|---|---|---|
| Chicago | 27 | 36 | 37 | 24 | 36 | 160 |
| Yale | 29 | 39 | 26 | 30 | 34 | 158 |
| Johns Hopkins | 17 | 30 | 33 | 38 | 33 | 151 |
| Harvard | 31 | 29 | 36 | 24 | 26 | 146 |
| Columbia | 32 | 25 | 21 | 33 | 22 | 133 |
| Pennsylvania | 14 | 25 | 9 | 20 | 24 | 92 |
| Cornell | 23 | 21 | 19 | 7 | 19 | 89 |
| Clark | 1 | 7 | 9 | 5 | 12 | 34 |
| New York | 4 | 6 | 7 | 9 | 5 | 31 |
| Michigan | 10 | 3 | 5 | 4 | 7 | 29 |
| Wisconsin | 6 | 5 | 5 | 7 | 5 | 28 |
| Virginia | 6 | 8 | 2 | 2 | 0 | 18 |
| Columbian | 2 | 3 | 5 | 0 | 1 | 11 |
| Brown | 2 | 2 | 3 | 3 | 1 | 11 |
| Bryn Mawr | 2 | 2 | 1 | 3 | 3 | 11 |
| Minnesota | 3 | 2 | 3 | 2 | 1 | 11 |
| Princeton | 1 | 3 | 3 | 3 | 0 | 10 |
| California | 1 | 2 | 2 | 3 | 1 | 9 |
| Stanford | 2 | 2 | 2 | 0 | 2 | 8 |
| Nebraska | 0 | 1 | 1 | 1 | 2 | 5 |
| Vanderbilt | 0 | 1 | 3 | 0 | 0 | 4 |
| Washington | 0 | 1 | 0 | 2 | 0 | 3 |
| Syracuse | 1 | 0 | 0 | 1 | 0 | 2 |
| Colorado | 0 | 0 | 0 | 1 | 0 | 1 |
| Kansas | 0 | 0 | 0 | 1 | 0 | 1 |
| Missouri | 0 | 0 | 0 | 1 | 0 | 1 |
| Tulane | 0 | 0 | 1 | 0 | 0 | 1 |
| | 214 | 253 | 233 | 224 | 234 | 1158 |

It may be seen from the table that the twenty-seven institutions are pretty definitely grouped. There are five institutions, Chicago, Yale, Johns Hopkins, Harvard and Columbia, whose number of doctorates during the past five years range from 160 to 133. Then come Pennsylvania and Cornell whose numbers are 92 and 87 respectively. These seven universities have conferred just four fifths of all the degrees that have been conferred by reputable institutions. Clark, New York, Michigan and Wisconsin form a group conferring about six degrees annually. With Virginia intervening, we next come to a group consisting of Columbian, Brown, Bryn Mawr, Minnesota, Princeton, California and Stanford, each of which confers about two degrees a year. There is then a drop to institutions conferring on the average one degree or less.

During the five years over which the statistics extend there has been no marked increase in the number of degrees conferred or alteration in the relative positions of the universities. The remarkable growth of the state universities is not witnessed by an increase in the number of degrees, but we may expect to see this in the course of the next five years. The 253 degrees last year were probably the largest number in the history of American education; but this year there is a drop to 214, the smallest number during the years covered by the records.

DOCTORATES CONFERRED IN THE SCIENCES.

| | 1902 | 1901 | 1900 | 1899 | 1898 | Total |
|---|---|---|---|---|---|---|
| Johns Hopkins | 9 | 19 | 20 | 17 | 19 | 84 |
| Chicago | 15 | 16 | 19 | 13 | 12 | 75 |
| Columbia | 14 | 13 | 12 | 23 | 10 | 72 |
| Yale | 10 | 18 | 10 | 15 | 11 | 64 |
| Harvard | 14 | 15 | 15 | 7 | 11 | 62 |
| Cornell | 16 | 13 | 11 | 2 | 11 | 53 |
| Pennsylvania | 5 | 12 | 6 | 8 | 8 | 39 |
| Clark | 1 | 7 | 9 | 5 | 12 | 34 |
| Wisconsin | 4 | 3 | 1 | 4 | 2 | 14 |
| Michigan | 5 | 0 | 1 | 3 | 0 | 9 |
| California | 1 | 2 | 1 | 3 | 1 | 8 |
| Bryn Mawr | 1 | 2 | 1 | 2 | 1 | 7 |
| Virginia | 1 | 4 | 0 | 2 | 0 | 7 |
| Columbian | 1 | 1 | 3 | 0 | 1 | 6 |
| Stanford | 2 | 1 | 0 | 0 | 2 | 5 |
| Nebraska | 0 | 1 | 1 | 1 | 2 | 5 |
| Brown | 2 | 1 | 0 | 0 | 1 | 4 |
| Minnesota | 2 | 0 | 1 | 1 | 0 | 4 |
| Princeton | 0 | 0 | 1 | 3 | 0 | 4 |
| New York | 0 | 1 | 0 | 1 | 1 | 3 |
| Washington | 0 | 1 | 0 | 2 | 0 | 3 |
| Vanderbilt | 0 | 1 | 1 | 0 | 0 | 2 |
| Colorado | 0 | 0 | 0 | 1 | 0 | 1 |
| Kansas | 0 | 0 | 0 | 1 | 0 | 1 |
| Missouri | 0 | 0 | 0 | 1 | 0 | 1 |
| Syracuse | 1 | 0 | 0 | 0 | 0 | 1 |
| | 104 | 131 | 113 | 115 | 105 | 568 |

In the second table similar statistics are given for the sciences. As has been stated in previous years, the distinction between the sciences and the humanities is somewhat arbitrary. In psychology, education, sociology and anthropology the attempt has been made to include the degrees under the sciences only when the thesis indicated that the subject had been treated as a natural science. It will be seen that the degrees are almost equally divided between the natural and exact sciences on the one hand, and languages, history, economics, philosophy, etc., on the other. Some universities appear, however, to favor one of the groups. Thus, Johns Hopkins, Cornell and Columbia have conferred more than half their degrees in the sciences, and Harvard, Yale, Chicago and Pennsylvania more than half in the humanities.

DOCTORATES CONFERRED IN THE SCIENCES.

| | 1902 | 1901 | 1900 | 1899 | 1898 | Total |
|---|---|---|---|---|---|---|
| Chemistry ..... | 24 | 28 | 26 | 32 | 27 | 137 |
| Physics ..... | 12 | 23 | 15 | 7 | 11 | 68 |
| Zoology ..... | 16 | 15 | 11 | 11 | 12 | 65 |
| Psychology ..... | 8 | 13 | 9 | 15 | 18 | 63 |
| Mathematics .... | 8 | 18 | 11 | 13 | 11 | 61 |
| Botany ..... | 11 | 8 | 12 | 11 | 11 | 53 |
| Geology ..... | 6 | 10 | 5 | 5 | 6 | 32 |
| Physiology ..... | 8 | 1 | 4 | 1 | 4 | 18 |
| Education ..... | 1 | 2 | 8 | 5 | 0 | 16 |
| Astronomy ..... | 2 | 5 | 4 | 2 | 3 | 16 |
| Sociology ..... | 4 | 3 | 3 | 5 | 0 | 15 |
| Paleontology .... | 0 | 1 | 2 | 4 | 0 | 7 |
| Anthropology ... | 0 | 1 | 2 | 0 | 2 | 5 |
| Bacteriology .... | 1 | 1 | 1 | 1 | 0 | 4 |
| Mineralogy ..... | 1 | 0 | 0 | 2 | 0 | 3 |
| Agriculture ..... | 2 | 0 | 0 | 0 | 0 | 2 |
| Anatomy ..... | 0 | 1 | 0 | 0 | 0 | 1 |
| Engineering ..... | 0 | 1 | 0 | 0 | 0 | 1 |
| Meteorology ..... | 0 | 0 | 0 | 1 | 0 | 1 |
| | 104 | 131 | 113 | 115 | 105 | 568 |

It is evident from the third table that about again as many degrees are awarded in chemistry as in any other science. There is then a group of sciences of nearly equal rank—physics, zoology, psychology, mathematics and botany—in which the numbers range from 68 to 53. There is then a drop to geology with 32 and to physiology with 18 degrees. Agriculture appears on the list this year for the first time with two degrees, and last year one degree was awarded in engineering. It is to be hoped and expected that research work in these applied sciences and in experimental medicine will increase. In regard to the cultivation of the sciences at different centers it appears that this year chemistry was relatively favored at Columbia, Johns Hopkins, Harvard, Yale and Pennsylvania; physiological chemistry at Yale; physics, zoology and psychology at Cornell; geology at Chicago, Harvard and Michigan, and botany at Chicago.

The names of those on whom the degrees were conferred in the sciences and the titles of their theses are as follows:

CORNELL UNIVERSITY.

Frank Allen: 'The Relation of Color-Blindness to the Fundamental Color Sensation.'

Leroy Anderson: 'Some of the Influences affecting Milk Production with especial reference to the Relation of Food to Milk Fat.'

John Wallace Baird: 'The Relation of Accommodation and Conveyance to the Perception of Depth.'

Peter Field: 'The Forms of Unicursal Quintic Curves.'

Charles Stuart Gager: 'The Development of the Pollinium and Sperm Cells in *Asclepias Cornuti* Decaisne.'

Elmer Edgar Hall: 'The Penetration of Totally Reflected Light into the Rarer Medium.'

William Atwood Hilton: 'The Morphology and Development of Intestinal Folds and Villi in Vertebrates.'

George L. Hoxie: 'The Induction Motor and its Engineering Capabilities.'

Carlotta Joaquina Maury: 'The Marine Oligocens of the United States.'

Kiichi Miyaké: 'The Development of the Archegonium and Fertilization in *Picea* and *Abies*.'

Henry Lewis Rietz: 'On Primitive Groups of Odd Order.'

Mary Jane Ross: 'The Origin and Development of the Gastric Glands of *Desmognathus, Amblystoma* and Pig.'

Augustus Valentine Saph: 'An Experimental Study of the Resistances to the Flow of Water in Pipes.'

Margaret Everitt Schallenberger: 'The Growth of the Child's Mind: A Study of the Development of Mental Structure.'

Lee Barker Walton: 'Evidence concerning the Double Nature of the Segment in Hexapoda, Chilopoda and Diplopoda.'

Floyd Rowe Watson: 'Surface Tension at the Interface of Two Liquids determined Experimentally by the Method of Ripple Waves.'

UNIVERSITY OF CHICAGO.

Wallace Appleton Beatty: 'Action of Sodium Alcoholates on Salts of Fatty Acids.'

Fred Harvey Hall Calhoun: 'The Relations of the Kewatin Ice Sheet to the Mountain Glaciers of Montana.'

Katherine Elizabeth Dopp: 'The Place of Industry in Elementary Education.'

Nevin Melancthon Fenneman: 'The Development of the Profile of Equilibrium of the Subaqueous Shore Terrace.'

Arthur White Greely: 'Studies on the Effects of Low Temperatures upon Morphogenetic Processes.'

Eugene Howard Harper: 'History of the Fertilization and Early Development of the Pigeon's Egg.'

Shinkishi Hatai: 'Studies on the Central Nervous System of the Rat and Cat.'

Edward Cary Hayes: 'The Sociologist's Object of Attention.'

Frank Baldwin Jewett: 'A New Method of Measuring the Vapor Density of Metals at Low Temperatures.'

Anstruther Abercrombie Lawson: 'Studies on the Morphology of the Nucleus.'

Burton Edward Livingstone: 'The Rôle of Diffusion and Osmotic Pressure in Plant Physiology.'

Florence May Lyon: 'Development of the Sporangium and Gametophyte of *Selaginella rupestris*.'

Thomas Milton Putnam: 'Concerning the Linear Fractional Group on three Variables with Coefficients in the Galois Field of order $p^n$.'

William George Tight: 'Origin and Development of the Ohio River.'

Frank Alonzo Wilder: 'The Age and Origin of the Gypsum of Webster County, Iowa.'

COLUMBIA UNIVERSITY.

Benjamin Arthur Bensley: 'The Evolution of the Australian Marsupialia, with Remarks on the Relationship of the Marsupials in General.'

Leopold Boroschek: 'Some New Derivatives of the Mono-nitro-ortho-phthalic Acids.'

Robert Henry Bradford: 'Reactions of the Ziervogel Process, and their Temperature Limits.'

William Austin Cannon: 'Studies in Plant Hybrids.'

Robert Heywood Fernald: 'Working Details of a Gas-engine Test, Including a Method of Determining the Temperatures of Exhaust Gases.'

Carl Gundersen: 'On the Measure or Content of Assemblages of Points.'

Cassius Jackson Keyser: 'The Plane Geometry of the Point in Space of Four Dimensions.'

George Alfred Lawrence: 'Studies upon the Cerebral Cortex in the Normal Human Brain and in Dementia Paralytica.'

Charles Edward Lucke: 'The Heat-engine Problem.'

Floyd Jay Metzger: 'A New Separation of Thorium from Cerium, Lanthanum and Didymium and its Application to the Analysis of Monazite.'

Charles Joseph Pretzfeld: 'A New Separation of Mercury from Arsenic, Antimony and Copper.'

Austin Flint Rogers: 'Crystallographic Studies.'

John Cutler Torrey: 'The Early Development of Thalassima.'

Lewis Addison Youtz: 'A Study of the Quantitative Determination of Antimony.'

HARVARD UNIVERSITY.

Ebenezer Henry Archibald: 'The Atomic Weight of Cæsium.'

Robert Stanley Breed: 'The Metamorphosis of the Muscles of a Beetle (*Thymalus marginicollis*, Chevr.).'

Frederick Alexander Bushée: 'Ethnic Factors in the Population of Boston.'

George Perkins Clinton: 'North American Ustilagineæ.'

Otto Dunkel: 'Regular Singular Points of a System of Homogeneous Linear Differential Equations of the First Order.'

Richard Blair Earle: I., 'On the Constitution of the Colored Compounds obtained from Sodic Alcoholates and certain Aromatic Compounds.' II., 'On the Action of Sodic Sulphite in Alcoholic Solution on Tribromdinitrobenzol and Tribromtrinitrobenzol.'

William Jay Hale: I., 'On the Oximes of Nitromalonic Aldehyde.' II., 'On the Condensation of Nitromalonic Aldehyde with Benzylmethyl Ketone.'

Cyrus Ambrose King: 'Observations on the Cytology of *Araiosfora pulchra* Thaxter.'

Frederick Meakin: 'Inhibition of Ideas.'

Edgar William Olive: 'A Monograph of the Acrasieæ.'

Carleton Estey Preston: 'Structural and Ecological Studies on Desert Vegetation.'

William Martin Smallwood: 'The Maturation, Fertilization and Early Cleavage of *Bulla solitaria*.'

Joseph Edmund Woodman: 'Geology of the Moose River Gold District, Halifax County, Nova Scotia; together with the Pre-Carboniferous History of the Meguma Series.'

Robert Mearns Yerkes: 'The Psychic Processes of the Frog.'

YALE UNIVERSITY.

Alling Pruden Beardsley: I., 'On the Action of Phenylhydrazine on Acylthiocarbamic and Acylimidothiocarbonic Esters: Pyro–a, $\beta'$—Diazole Derivatives.' II., 'On the Action of Phenylhydrazine on Benzoylpseudothioureas: 1, 5—Diphenyl—3—Amino—Pyro–a, $\beta'$—Diazole Derivatives.'

George Barton Cutten: 'Psychology of Alcoholism.'

Arthur Lyman Dean: 'Studies on Inulin and the Enzyme Inulase.'

Frank Eugene Hale: 'Starch and the Dextrins in Relation to Iodometry.'

George Arthur Hanford: 'Studies on the Physiological Action of Cæsium Compounds.'

Julius Olsen: 'An Experimental Investigation into the Existence of Free Ions in Aqueous Solution of Electrolytes.'

Leo Frederick Rettger: 'Experimental Studies on the Inter-Relation of the Spleen and Pancreas.'

Lyman Brumbaugh Stookey: 'Studies on Glycogen Formation.'

Ralph Gibbs Van Name: 'Analytical Applications of the Sulphocyanides.'

Lynde Phelps Wheeler: 'On the Reflection of Light from Mercury in Water.'

JOHNS HOPKINS UNIVERSITY.

Friend Ebenezer Clark: 'The Action of Substituted Ammonias of the Aliphatic Series on the Chlorides of Orthosulphobenzoic Acid.'

Arthur Byron Coble: 'A Study of the Ternary Quartic in its Relation to Conics.'

Charles Fowler Lindsay: 'A Study of the Conductivity of Certain Salts in Water, Methyl, Ethyl and Propyl Alcohols, and Mixtures of these Solvents.'

Louis Alexander Parsons: 'The Spectrum of Hydrogen.'

Henry Farnham Perkins: 'The Development of *Gonionema Murbachii*.'

Percy Goldthwait Stiles: 'On the Rhythmic Activity of the Œsophagus and the Influence upon it of Various Media.'

William Stone Weedon: 'An Investigation of the Oxidation Products of Phenylthiosalicylic Acid.'

John Boswell Whitehead, Jr.: 'The Magnetic Effect of Electric Displacement.'

Kisaburo Yamaguchi: 'An Investigation of the Hydrated Oxides of Manganese derived from Electrolytically-prepared Permanganic Acid.'

UNIVERSITY OF MICHIGAN.

Joseph William Tell Duval: 'Conditions Influencing Vitality and Germination of Seeds.'

Charles Edward Marshall: 'The Aeration of Milk.'

Raymond Pearl: 'The Movements and Reactions of Freshwater Planarians.'

Raymond Haines Pond: 'The Biological Relations of Aquatic Plants to the Substratum.'

Harrison McAllester Randall: 'The Determination of the Coefficients of Expansion of Nickel and Quartz at High Temperatures.'

UNIVERSITY OF PENNSYLVANIA.

Alfred Lewis Kammerer: 'Electrolysis of Bismuth Salts.'

Allen Rogers: 'Derivatives of Complex Inorganic Acids.'

Arthur Bertram Turner: 'Secular Perturbations Arising from the Action of Jupiter on Mars.'

Edwin Burkett Twitmyer: 'The Normal Knee-jerk.'

Levi Parker Wyman: 'The Purification of Tungstic Acid.'

UNIVERSITY OF WISCONSIN.

Benjamin Horace Hibbard: 'The History of Agriculture in Dane County, Wisconsin.'

Harrison Eastman Patten: 'Influence of the Solvent in Electrolytic Conduction.'

Oswald Schreiner: 'The Sesquiterpenes.'

Allyn Abbott Young: 'Studies in Age Statistics.'

BROWN UNIVERSITY.

George Ellett Coghill: 'The Cranial Nerves of *Amblystoma Tigrinum*.'

Millett Taylor Thompson: 'The Metamorphoses of the Hermit Crab.'

UNIVERSITY OF MINNESOTA.

Paul Maurice Glascoe: 'Derivatives of Camphor Oxime.'

George F. Wilkin: 'Social Control.'

LELAND STANFORD JUNIOR UNIVERSITY.

Ralph Arnold: 'The Paleontology and Stratigraphy of the Marine Pliocene and Pleistocene of San Pedro.'

Thomas Andrew Storey: 'Some Studies on Voluntary Muscle Contraction.'

BRYN MAWR COLLEGE.

Margaret Baxter MacDonald: 'A New Class of Disulphones.'

UNIVERSITY OF CALIFORNIA.

Alice Robertson: 'The Embryology and Embryonic Fission in Cyclostomatous Bryozoa.'

CLARK UNIVERSITY.

Andrew J. Kinnaman: 'Mental Life of two *Macacus Rhesus* Monkeys in Captivity.'

COLUMBIA UNIVERSITY.

Nevil Monroe Hopkins: 'Some Experiments on Electrolytic Conductivity with Reference to the Ion Theory.'

SYRACUSE UNIVERSITY.

William Erastus Taylor: 'On the Product of an Alternant by a Symmetric Function.'

UNIVERSITY OF VIRGINIA.

Heber D. Curtis: 'Definitive Determination of the Orbit of Comet, 1898, I.'

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## *RECENT PROGRESS IN ASTRONOMY.**

THE opening years of the twentieth century are full of remarkable and most striking evidences of man's power over the forces of nature, and yet with this feeling of might there comes to the thoughtful student, and perhaps especially to the astronomer, a deep reverential feeling of man's utter insignificance, and the littleness of his knowledge, in comparison with what is necessary for the complete mastery of the problems that present themselves.

Heat, light and electricity are the forces which have been so grandly made use of by the scientific man and the practical engineer. It is enough for me to refer only to the stupendous developments of the machinery making use of steam for locomotion on land and sea; to the great labor-saving devices used in the manufacture of steel and other needed things.

Still more marvelous are the applications of electricity; and the promises for the near future are most startling. I do not desire to develop these lines of thought, because I am aware that the young men of this institution, and especially those of the graduating class, have minds well stored with apt illustrations; and their imaginations can rapidly construct dreams of the future, based upon their own intimate knowledge of what has been done, and what is just on the point of being accomplished, by the application of heat and electricity.

This morning in my short address I wish to call your attention to *some* of the triumphs lately achieved by the use of light. And inasmuch as my work is mainly astronomical you will, I know, permit me to dwell entirely on the matter of celestial photography.

The United States has many reasons to be proud of what her astronomers have done both in the improvement of photographic telescopes, and in the results of photographic research; but the whole world has been active in applying this comparatively new instrument. The promise of future developments is indeed very gratifying. Every one is deeply interested in the study of the make-up of the solar and lunar surfaces. To-day photographic telescopes supply us with most of our accurate knowledge of details.

Exposures on the sun are made, lasting one to several thousandths of a second of time, which on development bring out the texture of the photosphere, the details of spots and spot groups, and the faculæ. These plates are taken with great regularity at several observatories in the world, and are studied at leisure by a trained force of observers. Rutherfurd in New York City from 1870 to 1874 took many solar photographs, the study of which has given us

* Commencement Address delivered at the Worcester Polytechnic Institute, June 12, 1902.

much valuable information. And since his time Greenwich, Paris, Meudon, Mt. Hamilton (Lick), Harvard, Yerkes and other observatories have taken thousands of plates. Many of my audience have seen such pictures thrown on a screen by the aid of a lantern, and thus have been able to study sun-spots, photosphere and faculæ in a most instructive and accurate way.

The earth's only visible satellite has always stirred the interest of the astronomer. Schmidt, of Athens, Beer and Mädler, of Germany, and many others have spent years of labor in making topographical drawings of the moon, and they published very fine maps. Thirty years ago Draper and Rutherfurd showed the world what excellent photographs could be taken with wet plates, and from that time many of the great observatories have collected hundreds of photographs of the moon on the very sensitive dry plates of recent years. We have now exquisite plates to study and measure. Lately the French government has published exact heliogravure copies and enlargements of the lunar photographs taken by Loewy and Puiseaux.

In this connection it is proper to call attention to the difference between an object glass for seeing and one for photography. The yellow rays affect the eyes most readily and so the lenses must be ground to bring those rays to a focus. But the blue and the violet rays affect most the photographic film. So that with a telescope arranged for seeing, the photographs obtained, in most cases, are hazy and indistinct. Rutherfurd, therefore, placed outside of his seeing object glass a lens of flint glass, so arranged as to bring the blue rays to a focus. It was with such a lens that he obtained his fine plates of the sun, moon and stars.

To-day this same system of lenses is mainly used, or a system involving the same principle. Lately, however, there has been discovered at the Yerkes Observatory a new method which gives great promise. When the University of Chicago bought the forty-inch object glass, they were unable to raise the money to buy the needed extra lens, which would enable them to photograph well the moon and other heavenly bodies. Fortunately, this was so, for it resulted in experiments by Mr. Ritchey which demonstrated the fine results to be obtained by a screen. This screen of colored glass was put in front of the sensitive plate, and allowed only the yellow and red rays to pass through the plate—it kept out the blue and violet rays—and, therefore, only those rays reached the sensitive plate which were accurately focused by the object glass. The result was some splendid photographs of the moon and its details, as fine as anything so far obtained. This discovery of the use of a proper screen gives the promise of converting any good seeing refracting telescope into a fine photographic instrument with very small expense.

The reflecting mirror when properly shaped brings to one focus all the rays of light; as well those rays which affect the eyes best as those which produce the desired result on the sensitive film. This fact has brought into increasing use the reflectors of large and small diameters. Modern methods of producing and mounting silver-on-glass mirrors have brought into considerable prominence the reflector especially for photographic work.

Gathering together all the photographs made from the time of Rutherfurd (1874) to the present, and later, will put into the hands of the selenographer means of determining the changes on the moon. Changes we most certainly expect. We are not aware that there exists anything which does not undergo change. But these changes may be so small and so slow to us that it may take years to discover them.

The surroundings of the sun—that region

which comes into view only at the times of total solar eclipses—the sun's 'crown of glory,' the corona—at present can be studied for about an hour during a century, if we estimate the time the astronomer has been able to actually see the corona.

But photography has here brought us most satisfactory results. Many negatives are now obtained at every eclipse of the sun, and these can be studied and measured at leisure. At an observing station for a total solar eclipse, the astronomer of fifty years ago would be dumbfounded to see how few and how small are the instruments set aside for the eye observations. All the large instruments and most of the observers' time are given to the photographic work. How fortunate this is—for not only can the originals be studied with great care, but copies can be furnished to all astronomers the world over for inspection and for comment.

In the past the discovery of new planets always excited a deep interest in the minds of men. To-day we are so accustomed to the discovery of new minor planets (sometimes as many as twenty-eight in one year) that we pass them by without much notice. You no doubt remember that the astronomers of the eighteenth century had great faith in Bode's law. This law stated that the planets were arranged in order of distance from the sun according to the numbers, 4, 7, 10, 16, 28, 52, etc. These numbers were obtained by writing down the numbers 0, 3, 6, 12, 24, 48. All the numbers after the second were obtained by multiplying the preceding number by two; and then adding four to each result. Representing the earth's distance as 10 the other numbers represented very fairly the distances of the other planets, but there was a break at 28. No planets were known at the distance 2.8 times the earth's distance from the sun. The law was so firmly believed in that in the latter part of the eighteenth century a number of astronomers joined in the search. They were dubbed the 'celestial police.' The first fugitive planet was found by Piazzi, January 1, 1801, an astronomer of Sicily, who had not yet received notice of his appointment on the force.

Then the search was later taken up most vigorously, and down to 1892 about 325 were discovered. But in the latter part of the preceding year Dr. Wolf, of Heidelberg, inaugurated the scheme of photographing the heavens. He made his exposures in duplicate, and for two or three hours. The result was that if a minor planet was in the field, as the telescope was guided by following accurately a star, the planet's moving caused a short dash to appear on the plate instead of a round star image.

The plates were measured and from these measurements the astronomer could determine whether the planet was new or an old one. In carrying out this work Dr. Wolf, Charlois of Nice, and others have been so successful that, since November 28, 1891, the list of minor planets, mainly discovered by photography, has increased to nearly five hundred. Wolf's work attracted the attention of the late Miss Catherine Wolfe Bruce, of New York City, who has done so much for astronomy. Miss Bruce gave Wolf the means to build a fine photographic outfit. The new apparatus he had built in this country, and is now using with the most excellent results. He has immortalized that noble, generous woman by naming one of the planets Brucia. He showed his appreciation of the work of the Lick Observatory by giving the appellation of California to the planet he discovered on September 25, 1892, and he had previously named another Chicago, after the city he expected to visit during the Exposition of 1893.

Photography has so rapidly increased the number of these little planets that there has been some serious discussion as to whether

it may not be wise to let them go; the calculations and observations necessary to keep track of them are considerable and expensive.

This method by the use of larger lenses, longer exposures and more sensitive plates, may show thousands of little bodies, circulating not only between the orbits of Mars and Jupiter, but even between the orbits of all the other planets.

If celestial photography had been known in 1846 and previously, then the discovery of Neptune would have been made by Challis at Cambridge, England, with great ease.

It was by photography that Herr Witt in 1898 discovered that most interesting minor planet named by him Eros. This is the first body whose orbit has been proved to lie mainly within the orbit of Mars—moving in such a path that at perihelion the earth and planet are separated by about 15,000,000 miles. Here, then, we have a grand opportunity for determining its parallax and so getting a new value of the sun's parallax, and hence its distance in miles. Such use has already been made of Eros. A large number of observatories took in 1901 photographs of the planet, and these are to be measured and reduced. But Eros will be better situated in later years, so that during the twentieth century the sun's distance will be obtained with great accuracy. To-day we know that distance with an uncertainty of about 150,000 miles —at the end of the century the uncertainty ought to be reduced to 25,000 miles or less. Under the most accurate methods of the present day base lines on this little earth can be measured with an error of even less than one part in a million—or one inch in a million inches, *i. e.*, one inch error in measuring a line nearly sixteen miles long, or half an inch error in measuring a line nearly eight miles long.

Such accuracy we can hardly hope to reach during the twentieth century in obtaining the distance of the sun from the earth. Such an error would amount to over ninety miles. One mile seems a large unit to us, but it is an exceedingly small measuring unit for sounding the depths of space.

The business men of the world are proving to us that there is a great benefit for some one in big combinations of shops and men. The effect in some cases has been to improve machinery, better the output and to reduce prices. This idea of cooperation has taken hold of the scientific mind. To-day seventeen observatories are engaged in making maps of the heavens by photography. Seventeen observatories from Finland to the Cape of Good Hope have been busy for the past ten years in obtaining the images of stars on the sensitive plates. Their plan is a most interesting one for the astronomer. It was arranged by conferences of astronomers who met several times at Paris. The heavens have been divided into belts parallel to the equator, and each observatory photographs one or more belts completely around the sky. In order to guard against error a peculiar system has been adopted; each plate is exposed for twenty seconds, the telescope in the meantime following the star with great nicety. Then the plate is moved a trifle and another exposure is made lasting three minutes, and in a similar way a third exposure is made for six minutes. These three images of a star are very close to each other. Every *bright* star will make three images. The *faint* stars will give only two images and the *very faint* stars one image. This enables the astronomer to judge of the brightness of the stars, and also to discriminate between defects on the plate and real images. In order to tie a plate to its neighboring plates they are made to overlap, so that twice the number necessary to once cover the sky is taken. This makes 22,000 plates. Many of these have now been made and the plates have been measured to de-

termine the relation of the stars to each other. The catalogue to be published is likely to contain about 2,000,000 stars down to the 11th magnitude. When done, we shall have the most valuable and extensive star catalogue ever constructed.

In addition to these plates the observatories doing this work will also take plates with exposures lasting thirty to fifty minutes (depending on the atmospheric conditions). These plates will probably show some 20,000,000 stars.

To measure their positions and to reduce the measurements would require much time and money—more than the astronomers and their patrons can afford to give. It has been decided, however, to enlarge these plates by proper lenses and to make a heliogravure of the enlargement. The liberal French government has been the first to publish a large number of these charts, which show stars down to the fourteenth magnitude and are invaluable for studying at leisure a given part of the sky. Each plate covers about four square degrees.

In our own country Professor E. C. Pickering, of Harvard College Observatory, has employed the Bruce telescope and other instruments to make photographs of the heavens. Pickering by his system is able to take a larger area on each plate and finish his survey in a shorter time. He has thus been able to collect a magnificent library of plates which have proved most valuable in the past and are likely to prove more precious in the future. Professor Barnard and others have given considerable time to using instruments which show large areas of the heavens with exposures of several hours. The wonder-exciting result is obtained showing that the number of stars goes on increasing. When will it end? What does it mean? The astronomer bows his head in awe-full ignorance!

To-day we are all amazed by the promises of wireless telegraphy. Messages across the ocean seem likely to be coming soon from every direction without going through cables.

Wireless telegraphic communication with the sun, planets and stars the astronomer has had for some time past. The messages are received by a specially devised apparatus called a photospectroscope, and the cipher dispatches are styled spectra. These spectra are photographed on glass and are measured, reduced and interpreted by the expert. In the use of this instrument our own country has done much, and the names of Young, Pickering, Langley, Keeler, Campbell, Hale and others stand high in the list of astrophysicists.

What are the stars made of? What materials are in the sun and in comets? in nebulæ? The light from these bodies speeds onward with a velocity of over 180,000 miles a second and takes more than four years to come from the nearest star. Even to come from the sun requires about 500 seconds of time. These light vibrations enter the telescope and pass into the spectroscope, and proper apparatus enables us to obtain a message which tells us what are the gases in the sun, stars, comets and nebulæ.

Moreover, this resultful instrument gives us the power to determine motion and its rate to and from the observer. The stars are so distant that a line 93 millions of miles in length would look to the inhabitant of the *nearest star* as a line about two-tenths of an inch long would appear to you when placed a mile away!

Motion to or from us of an object so far away has hitherto been impossible to measure. The spectroscope solves the problem. If a star is moving toward us then there is a displacement of lines in the stellar spectrum toward the blue end, and if it is going from us the displacement is to the red end. By proper comparison-measurements the rate of motion can be worked out. This

information is most important for the purpose of calculating the orbit or path in space of the star examined.

Then, too, the same principle gives us the power to measure the rotation times of the sun and planets, because we can bring into view two opposite sides of the sun or the planet's disk; these opposite sides revolve, one toward us, the other away, and the spectra of the two sides show displacements of lines in opposite directions. The amount of displacement gives the velocity of rotation. For the sun and planets these results obtained by the spectroscope are checked by independent observations, such as watching the spots on the sun and on Jupiter.

The power of the spectroscope to measure motion in the line of sight has recently been used by the late director of Lick Observatory, California, Keeler, and by the present director, Dr. Campbell, in solving two most interesting problems. When Saturn's rings were first discussed it was thought they were solid. Then it was shown that a ring system nearly 170,000 miles in diameter and about 100 miles in thickness could not endure, without destruction, the diverse pullings due to the gravitation of forces exercised by the planet and the satellites. A fluid system of rings was found to be unstable also, and the theory was adopted that the rings are composed of millions of small satellites so aggregated that they reflected sunlight to us and gave the appearance of solidity, like a cloud in the summer sky. This theory of the structure of the rings was styled the meteoric theory: it rested almost entirely on the mathematical argument. But Keeler in 1895 confirmed this theory in a beautiful manner by the use of his spectroscope. The slit of the spectroscope was made to pass through the center of the image of the planet and through the rings, and he obtained a photograph of the spectra of the rings and the planet. Then, on examination, the lines in the spectra were found to be conspicuously inclined, and inclined in such a way that the planet was shown to be revolving as a solid body, while the rings were revolving only as they could revolve if composed of separated satellites. Thus we have the final proof that the rings are neither solid nor liquid, but are meteoric. Keeler's results have been confirmed fully by other observers.

The question has often been asked, 'Does the solar system as a unit remain fixed in space, or is it moving in a known direction?' How can this be determined? When we look down a long straight line of railroad track we note that the separate tracks appear to come closer together as the distance sighted becomes greater, and if the distance is long enough the tracks appear to actually come together. Now if we walk down the track we discover that this coming-together point moves away from us—the tracks open in the direction we are walking and on looking back the tracks appear to be closing in. An effect similar to this would show itself when we look at the stars, if the solar system is moving in space. Those stars, situated at the point towards which we are moving, will gradually open out, separate, and those stars in the opposite direction would appear to be coming together.

Observations have been made to determine these directions; with the result that they seem to show that the sun, carrying with him his family of planets, is moving towards a point near the eastern edge of the constellation of Hercules, with a velocity of about fifteen miles a second. But observers differ quite a little in their results. Campbell has undertaken to investigate the subject by studying the velocity of stars in the line of sight by the use of the spectroscope. The examination of many hundreds of stars ought to bring out the result, that in the direction we are moving the general average displacement of lines in the spectra

should be toward the blue end, and the opposite effect would show itself in examining stars in the direction *from* which we are moving. Campbell has examined many stars in the northern sky, and soon will go to Chile to continue his observations. The final result will give us both the point among the stars toward which the solar system is going and the velocity. These facts being known, the astronomer may be able in the future to calculate when the sun and his family will come into dangerous proximity to other great systems in space. Such thoughts need not worry us as the time is to be reckoned in thousands of years!

The spectroscope applied to sun, planets, stars, nebulæ, comets and meteors, has given us a splendid record, and the present century is full of promises of greater results.

To-day in all great observatories photography is used to obtain permanent records of sun, planets and stars, etc. When we study the photographs taken, we are impressed with the fact that our sensitive plates, when exposed to an object, will show on development more and more, depending on the time of exposure. The startling information is obtained that after from ten to twenty-five hours or more exposure we can obtain a photograph which will show us what we never can hope (as far as we now know) to see in our telescope! Let us give our imaginations free rein, and we may dream of getting only general information with our eyes, but by the use of sensitive plates in photography we may make amazing discoveries all around us of things the eye cannot see.

In conclusion let me quote the words of one of our ablest workers in celestial photography:

"If we were asked to sum up in one word what photography has accomplished, we should say that observational astronomy has been revolutionized.

"There is to-day scarcely an instrument of precision in which the sensitive plate has not been substituted for the human eye; scarcely an inquiry possible to the older method which cannot now be undertaken upon a grander scale. Novel investigations formerly not even possible are now entirely practicable by photography, and the end is not yet.

"Valuable as are the achievements already consummated, photography is richest in its promise for the future. Astronomy has been called the 'perfect science'; it is safe to predict that the next generation will wonder that the knowledge we have to-day should ever have received so proud a title."

Columbia University. J. K. Rees.

## *American Association for the Advancement of Science. Section I, Economic and Social Science.*

In the absence of Hon. Carroll D. Wright, Commissioner of Labor, Mr. John Hyde, Statistician of the Department of Agriculture and Vice-president of the section for the Denver meeting, presided over the Section. On the afternoon of June 30 the vice-presidential address of Mr. Hyde, on 'Some Economic and Statistical Aspects of Preventable Diseases,' was delivered. The address will be published in full in Science. Meetings for the reading of papers were held on the morning and afternoon of July 1, the morning and evening of July 2 and the morning of July 3. The meeting on the afternoon of July 1, at which the papers of Messrs. Alvord, Powers, Beal and Lazenby were read, was held jointly with the Society for the Promotion of Agricultural Science.

Titles and abstracts of the papers read in full are as follows:

*Economic Situation of Pittsburgh:* George H. Anderson, Secretary of Pittsburgh Chamber of Commerce.

Greater Pittsburgh, comprising Allegheny County, ranks fourth in population

and first in manufacturing industry among the cities of the United States. It leads the world in the production of steel and iron, steel cars, steel and wrought-iron pipe, and tin plate; of plate glass, tumblers and window glass; of air-brakes and electrical machinery; of coal and coke; of petroleum, etc. The freight movement during the year 1901 reached over 75,000,000 tons. The conditions to which the economic preeminence of Pittsburgh is due are as follows: (1) Cheap and abundant fuel; (2) exceptional facilities for railway and water transportation; (3) improved machinery and scientific methods of production. The union of these conditions, in unequaled degree, explains Pittsburgh's industrial supremacy.

*The Electrical Industries of Pittsburgh and their Economic Influence:* GEORGE H. GIBSON, Pittsburgh.

The most important electrical industry of Pittsburgh is the work carried on by the Westinghouse Electric & Mfg. Co., whose present plant occupies a site of 40 acres, and employs 5,300 men and 1,200 women. This immense plant is shortly to be duplicated.

The modern industrial age began with the advent of the steam-engine, but, in order to utilize the power of the latter, some means of transmission was necessary. The agent par excellence for power distribution is electricity. Electricity has furnished, also, the most useful means of lighting, and electro-chemistry has opened up a new but rapidly developing branch of industries.

Electric traction is an important factor in developing cities, redistributing populations, building up suburban districts and affording convenient transportation for farming communities. Some of the interurban roads are operating cars at fifty miles per hour and many carry mail, freight and express and even run sleeping cars. On account of the convenience, frequency and cheapness of their service, electric roads are making a new field for themselves which was not open to and does not compete with steam roads.

In the modern factory the use of electricity conduces to profitable operation and permits the erection of cheaper buildings, their easy and convenient extension with the growth of business and an arrangement of tools advantageous to increased output. The use of electric cranes, hoists, etc., liberates the workman from the severe and more common sorts of labor and tends to raise him to a higher grade of intelligence and efficiency.

In mining, electricity as a means of power transmission is unique in possessing all the advantages and possibilities of other methods and escaping their disadvantages. It is adapted to all classes of work and is used for hoisting, hauling, drilling and excavating in general, ventilating and pumping, as well as the additional use of lighting, which is possible with no other method. Electric wires may be run anywhere, they are easily laid, occupy small space and may be tapped at any moment at any point. The use of coal-cutting machines has not only released the miner from much severe labor but has resulted in a saving of $5,300,000 per year in the United States. The extent to which electricity is adopted corresponds very closely to the extent to which mine owners and managers become familiar with this new means at their disposal.

The possibility of transmitting electric power over distances as great as 200 miles has added resources to such localities as Niagara and Messena, N. Y.; Sault Ste. Marie, Mich., and Snoqualmie Falls in the State of Washington. The largest transformers used for long distance transmission have recently been constructed in Pittsburgh, with a capacity of 2,700 kilowatts. In Pittsburgh too have been built the larg-

est dynamos ever made, viz., those for the Manhattan Elevated Railway of New York City.

Electro-chemistry has not only made aluminum a rival of copper as an electric conductor, but nearly all the copper is now electrolytically refined. Calcium carbide, from which acetylene is generated, is formed under the electric arc; ordinary bleaching powder is manufactured from common salt by an electrolytic process; carborundum, a new abrasive more effective than emery, is made in the electric furnace, which aspires to the manufacture of graphite and even diamonds. Electrically generated ozone is used for the purification of water, and a company has even been formed to perfect a process for burning the nitrogen in the air for the commercial production of nitrates, which may go far to postpone the impending wheat famine predicted by Sir Wm. Crookes.

Electric lighting represents an investment of $669,000,000 in the United States. Great improvements have lately been made in electric lamps. These include the Nernst lamp, which is a new form of incandescent lamp; the Bremer lamp, a new arc lamp; and the Cooper-Hewitt mercury vapor lamp, in which use is made of the incandescence of a vapor or gas. The development of new inventions, often very costly, is carried on here in Pittsburgh as an adjunct to regular manufacturing.

Mechanical and engineering development is a measure of a country's civilization, and the United States possesses 69 per cent. of all the electricity available in the world, 76 per cent. of all that portion available for traction, 76½ per cent. of all the electric railway mileage and 83½ per cent. of all the trolley cars.

*The Genesis of Pittsburgh as a Seat of Iron Manufacture:* J. B. Johnston, of the Pittsburgh *Post*.

*Some Consequences of the Trust Movement:* H. T. Newcomb, Editor of *The Railway World,* Philadelphia. (Published in *The Railway World* of July 5, 1902.)

*The Statistics of the Dairy:* Henry E. Alvord, Chief of Dairy Division, U. S. Department of Agriculture, Washington. (This paper will be printed in full in the *Proceedings of the Society for the Promotion of Agricultural Science.*)

The relative importance of this branch of agricultural industry in the United States is pointed out and the value of accurate statistics thereof. The United States Census is regarded as the principal source of statistical information on this subject, but is by no means the only one. The enumeration of cows is the basis of reliable dairy data, and this count by the twelfth census is believed to be more complete and accurate than any preceding. It included for the first time the cows not on farms and ranges —found to be 973,033 in number, or 5½ per cent. of the entire milking stock of the country. The whole number of dairy cows, according to the census of 1900, was 18,112,707, and this is accepted as correct. Reasons are given for believing the enumeration of cows by the census of 1890 to be entirely unreliable and hence all the dairy statistics connected therewith. Consequently, comparisons between the dairy data of the eleventh census and the twelfth are considered as entirely misleading and useless.

Certain items in the dairy statistics of the last U. S. census are pointed out to be much more reliable than others. The following arrangement is presented as the probable order of accuracy: (1) The number of dairy cows, (2) the materials and products of the condensed milk factories, (3) the products of the cheese factories, (4) the products of creameries, (5) the cheese made on farms and sold therefrom, (6) the milk

received at cheese factories, (7) the butter made on farms and sold therefrom, (8) the milk and cream received at creameries, (9) the butter and cheese made on farms and there consumed, (10) the total milk produced on farms, (11) the milk and cream sold from farms. The first three or four of these items are considered approximately accurate; the last three or four are easily shown to be very inaccurate.

A number of tables, statements and computations are given and the deduction therefrom explained, showing that items numbered above 8, 10 and 11 must be much greater than given by the census, and that most erroneous conclusions would be reached as to the consumption of milk in its natural state, unless arbitrary but rational modifications were made of the published statistics. Two important factors have to be supplied by estimates: (1) The milk product of the 'town cows,' placed at 4,000 lbs. per year each, and (2) milk consumed by dairy calves, the estimate being 15,000,000 calves at 350 lbs. each, making an immense total, one twelfth of the entire milk product of the country.

Accepting those census statistics which bear tests of reliability, and modifying others according to the most reasonable probabilities, a table is presented as being likely to approximate the truth as to the dairy industry for the last census year. With further modifications, another table is offered as giving the probable facts, in round numbers, for the present year, as follows:

ESTIMATES OF DAIRY STATISTICS OF THE UNITED STATES FOR 1902.

| Millions. | Millions of Pounds of Milk. |
|---|---|
| 80 persons, at 65 lbs. per day, consume per annum | 18,980 |
| 200 lbs. condensed milk require | 800 |
| 300 lbs. cheese require | 3,000 |
| 1550 lbs. butter require | 36,422 |
| 12 gals. cream require | 540 |
| 15 dairy calves consume | 5,050 |
| Total milk used as above | 64,792 |

This is the product of 18,200,000 cows, at 3,560 lbs. each per year.

The annual consumption of dairy products per capita in the United States, based upon the census statistics of production, as modified and with proper allowances for exports and imports, is believed to be very nearly as follows: 19 lbs. 3 oz. of butter; 3 lbs. 7 oz. of cheese; 1 lb. 4 oz. of cream; 2 lbs. 4 oz. of condensed milk, and 237 lbs. 4 oz. of fresh milk.

*The Passing of the Hired Man on Farms:* L. G. POWERS, Chief Statistician, United States Census, Washington.

1. The greater increase of farms than of farm population and its significance.

(*a*) All farms and population.
(*b*) Farms containing over fifty acres and population.
(*c*) Farms operated by owners and population.
(*d*) Farms operated by tenants and population.
(*e*) Farms and agriculturalists other than farm owners and tenants.

2. Farm ownership, tenancy and wage service at different ages of life.

(*a*) Farm owners of specified ages.
(*b*) Farm tenants of specified ages.
(*c*) Farm laborers of specified ages.

3. The economic changes of the farm and the city contrasted.

4. Increasing economic independence on the farm.

*Observations by a Country Roadside:* W. J. BEAL, Michigan Agricultural College.

The paper was illustrated by about thirty lantern slides and was intended to show the objects of interest and of general significance on the road from Okemos to Lansing, passing by the Agricultural College—a distance of five or six miles. It was intended as a suitable exercise for a bulletin on elementary science, or nature study. The objects illustrated were an old grist mill; a country repair shop; a curve in

the river washing out the bank, where all the woody growth had been cut away; a country cemetery; a dangerous railway crossing concealed by high banks; a flat sandy road always bad in dry weather; a neat farmhouse with mail-box for free rural mail delivery; some old apple trees going to decay; fields extending near the highway with no fences; an old log house going into decay; a farm wood-lot where the trees are dying because it had been pastured; a perfectly graded highway; an old hawthorn; a view of the college campus; a deer park; the arboretum, twenty-seven years old; a large fine American elm; trees disfigured by telephone wires; fine views with nature's planting and the same after the woody growth had nearly all been removed; a neat modern cottage; a new brick school-house; a big split stone, with a cherry tree growing between the pieces; advertisements on board fences; a watering trough: two trees that survived after they had broken over; the State Industrial School.

*The Timber Trees of Ohio and their Economic Uses:* William R. Lazenby, Ohio State University, Columbus.

A scientifically classified list of all the timber trees of Ohio with notes on their distribution and abundance. The principal demands or present economic uses of wood are classified under fifteen different heads. Among these are building material, fencing, railroad cross-ties, poles for electric wires, transportation vehicles, cabinet ware, agricultural implements, household utensils, packages, paper, walks and roads, chemical industries, mining purposes, fuel and charcoal, miscellaneous uses.

The amount and kind of timber for each of the above uses are briefly discussed and a list of woods used for minor but specific purposes is appended.

*The Importance of Cooperation between the Federal Census Office and the State Statistical Offices:* Carroll D. Wright, Commissioner of Labor, Washington. (Published in 'Report on Manufactures,' U. S. Twelfth Census, Pt. I., pp. xl.–xlv.).

The law creating the permanent Census Office provides that in 1905 and every tenth year thereafter there shall be a collection of the statistics of manufactures; this is in addition to the regular decennial census as usually taken. The various State offices are constantly engaged in collecting data relative to manufactures; hence it becomes very necessary that duplication should be avoided wherever possible, and that the expense involved in the work of State and Federal governments should be either shared by them or, so far as possible, avoided entirely on the part of one or the other. Probably there is not a State in the Union that does not collect statistics relative to some of the subjects enumerated in the law establishing the permanent Census Office, and, specifically, there is a great chain of State statistical offices, known as such, having duties similar to those prescribed for the permanent Census Office. Thus a mass of information is published each year, and especially every ten years, so great that students and statesmen find it difficult to study the details sufficiently to enable them correctly to interpret results.

The fact that the results are open to criticism is perhaps the smallest matter, but certainly all data should be published in as correct a form as possible and properly interpreted and systematically and conveniently presented for public use. This desirable result can be assured only by avoiding the duplication of work, by systematizing the methods under which statistics are gathered, and by a uniform codification of the results, to accomplish which desired end it is absolutely essential that there

should be some system of cooperation between the State and the Federal offices.

Another strong argument in favor of such cooperation is derived from the fact that at present the State and the Federal governments are constantly canvassing manufacturing establishments and the people generally for statistical data. This duplication, or rather repetition, of attempts to secure information is becoming very annoying to the public generally, and causes the fear that there will be a revolt on the part of some interests, and makes it essential that these canvasses should take place as rarely as possible. Constant calls for information where no remuneration is provided for furnishing it result oftentimes not in careless answers but in positive refusals to comply with official requests. Again, while governments are constantly requesting manufacturers and others for information, the secretaries of trade associations, the editors of almanacs and yearbooks, and the compilers of encyclopedias and other works, are also besieging them for specific information for their various publications. These calls complicate the work of government offices.

*The Change of Position, during the Nineteenth Century, of the Business Corporation:* JUDGE SIMEON E. BALDWIN, Supreme Court of Connecticut, New Haven.

The close of the nineteenth century found the business of the world in the hands of private business corporations. It was not so in 1800 nor at any previous time in the history of the world. How came it?

The existence of such artificial persons was first freely permitted by Rome under the republic; but they grew so powerful that this could not be tolerated under the empire. The only form of Roman corporation (*universitas*) which survived to reappear in the beginnings of modern society was the university of scholars. Private incorporation at will under general laws, for business purposes, remained unknown for nearly 1,800 years. The few corporations of this kind that did exist existed under a special franchise. They were monopolies. They often grew inconceivably great. They fostered speculation, and were generally distrusted by the people. Great commercial partnerships were resorted to for large undertakings. Prior to 1800 there were only 225 business corporations in the United States, and of these two thirds were to promote quasi-public objects like canals, etc. The first American general incorporation law was for canals, in 1795. New York followed in 1811 with one for certain kinds of manufacturing enterprises, and in the course of the next seventy years freedom of incorporation on equal terms to all became the rule in almost all civilized countries. The freer and the richer a country is, the freer will be its general incorporation laws, and the more numerous the corporations formed under them. This and the enormous increase of the world's wealth since 1800 are the two factors which have put into the hands of the modern corporation the business of the world.

Sentimental considerations largely influenced this course of events. Popular distrust and jealousy kept men from investing in corporations or from wishing them well, so long as their character was monopolistic. The modern corporation is individualistic. It asks nothing from the State but to be let alone. The 'trust' at first was an abandonment of the corporate idea for that of partnership. Now it is reverting to the corporate type. The mobility of most business corporations is as great as is that of a natural person. It is greater, for they can choose their birthplace, and incorporate where they find incorporation offered on the easiest terms. They can also reincorporate subsequently in some other State, and so, Phœnix-like, die and revive again.

Mill said that industry was limited by capital. The modern corporation in a world with surplus wealth on every side eager for investment has removed this limitation.

*Problems and Possibilities of a Department of Commerce:* John Franklin Crowell, Bureau of Statistics, Treasury Department, Washington.

Unexpected difficulties in administrative organization, more than anything else, prevented the enactment of the law creating a Department of Commerce at the latest session of Congress. Debate and hearings, however, developed the seemingly general conclusion that an efficient department could not be created out of more or less incoherent and semi-commercial bureaus as constituent elements, but that such a department would probably have to be started *de novo* and develop its own administrative machinery. The field for such a department in domestic commerce is full of unsolved problems, such as the railway problem, the trust problem, the shipping problem, the navigation problem and the problem of the development of trolley traffic and highway improvement. All of these are vital commercial problems which have almost no representation in federal administration and no direct representation in the cabinet. Add to these all those questions which are involved in the proposals to extend our foreign markets through the agency of the federal administration, and we have a sufficient scope for a most energetic executive department. These considerations should put to rest the doubt whether there is any place for such a division of administrative activity. If our commerce is to be reduced to a scientific business rather than to remain as a speculative hazard, then governmental leadership is necessary to focalize the policy which, taking into account both domestic and foreign trade, would contribute most to our permanent prosperity.

*The Development of American Commerce—Past, Present and Prospective* (accompanied by diagrams): O. P. Austin, Chief of Bureau of Statistics, Treasury Department, Washington. (Published in *The World's Work*, August, 1902.)

The foreign commerce of the United States divides itself into three distinct periods: (1) That prior to 1870 when the growth was comparatively slow and the imports usually exceeded the exports, (2) that following 1870, in which the growth was more rapid and the exports usually exceeded the imports, and (3) that of the last decade, in which manufactures form an increasing share of the exports and manufacturers' materials an increasing share of the imports. Following the construction of the transcontinental railway, completed in 1869, came the extension of other lines through the great Mississippi valley and the South, and this resulted in the opening of the great agricultural, forest and mineral areas whose natural supplies have made this the greatest producing country of the world and facilitated the assembling of these natural products for use in manufacturing. As a result, agricultural production has more than doubled and manufactures more than trebled. The value of farm products increased from less than $2\frac{1}{2}$ billions of dollars in 1870 to about $4\frac{3}{4}$ billions in 1900, and the value of manufactures has grown from $4\frac{1}{4}$ billions in 1870 to 13 billions in 1900; though in each case the figures of value fail to show the full growth in production, owing to the fall in prices of nearly all articles meantime. The production of coal, a prime necessity in manufacturing, grew from 33 million tons in 1870 to 290 millions in 1901; pig iron, from less than 2 million tons to over 13 million tons. Meantime the rail-

ways have grown from 52,000 miles in 1870 to practically 200,000 miles at the present time, and rates for rail transportation have fallen to about one third the rates of 1870. The result of all this is that the United States has become the greatest exporting nation in the world, having risen from fourth place in 1870 to first place in 1901. The value of our exports was, in 1870, 393 millions; in 1901, 1,487 millions; imports, in 1870, 436 millions; in 1901, 823 millions.

The causes of this development in exports are to be found in the fact that the United States is the world's largest producer of the great articles required by man for his daily life. The chief requirements of man are food, clothing, heat, light and manufactures; and of all these the United States is the world's largest producer: for food, wheat, corn and meats; for clothing, cotton; for heat and light, coal and petroleum; for manufacturing, iron, copper and lead; while in manufactures actually produced the United States exceeds any other nation.

This commanding position in the world's commerce seems likely to be retained by the United States. The natural production shows little if any signs of abatement, while we may reasonably expect that the development of science and invention and the application of American energy will still further reduce the cost of manufacture and transportation. This high standing of the United States as an exporting nation should be welcomed by the commercial world rather than antagonized. The commercial world buys our products because it requires them for daily use and because it can obtain them more readily and cheaply from the United States than from any other part of the world. The effect of the refusal of Europe to purchase from the United States any of the great articles of which we furnish so large a proportion of the world's supply would be to cause an advance in the price of those articles in other parts of the world, while the fact that the United States in 1901 sold to Europe alone more manufactures than she ever sold to the entire world in any year prior to 1895 shows the progress that American manufacturers are making.

It must also be expected that our imports will continue to grow. The reasons are coincident with our growth in manufactures. While the United States is the world's greatest producer in the chief elements required in manufacturing, it does not produce certain articles of tropical and subtropical growth of which the manufacturers are requiring constantly increasing quantities, such as raw silk, fibers, Egyptian cotton, india-rubber and many other articles of this character. Add to this the tropical requirements for food, such as coffee,cocoa, tea and such portions of the sugar and tropical fruits as are not produced at home, and it is apparent that the importations must increase, and especially those from the tropics. This fact of our growing dependence upon the tropics suggests that the events of the past four years have been of advantage in the fact that they have brought under the American flag an area capable of producing a large share of these tropical requirements, and taking an equal quantity of our products in exchange therefor.

*New Light on the Per Capita Wheat Consumption Problem:* HENRY FARQUHAR, U. S. Census Office, Washington.

The census results recently published from the flouring mills of the country in the year ending with May, 1900, include amounts of flour produced and of wheat used in its production, which, taken in connection with amounts exported during the same period, furnish an index to the country's consumption of flour, and hence of wheat. The consumption so ascertained

from the Twelfth Census agrees closely with that from the Eleventh, from flour mills; and they differ very little from those deduced from the last census for agriculture, making allowance in the latter for all wheat not consumed for food in this country. But the per capita figure from these concurrent sources is some twenty per cent. in excess of the amount which appeared to result from previous inquiries, by the reported consumption of representative families, converted into an average for the country by use of population tables for different localities and classes.

The quantity found by the latter method might be deficient in several ways: the amount consumed might be underestimated; or wastes and losses and consumption other than as human food might be neglected; or the number of consumers might be overstated, owing to absences from home, etc.; or the families considered might be not fairly representative. The census determination might be excessive through faulty methods of supplying imperfect data—for example, overestimate of the amount of wheat required for a barrel of flour. The least improbable source of error in the agricultural census would be an introduction of supposititous farms by the enumerators. It is possible also that the per capita rate might actually have increased.

*Municipal Insurance against Unemployment:* Henry J. Harris, Department of Labor, Washington.

The four causes which force the workingman involuntarily to become a burden to society are accident, sickness, general invalidity and lack of employment. The first three of these have been more or less successfully removed from the field of charitable effort and relief for them placed on the basis of insurance; attempts are now being made in various European countries to place relief for unemployment on a like basis.

The first attempt to accomplish this was made in the city of Bern, Switzerland, in 1893, by establishing a municipal office for voluntary insurance against unemployment. The plan finally adopted was to charge the members of the Fund the sum of fifty centimes per month as dues, and in case of a member becoming unemployed—through no fault of his own—during the months of December, January and February, he was paid one and one-half francs (or two francs if others were financially dependent on him) per day for a period not exceeding sixty days. With modifications to suit local conditions, similar Funds have been established in Basel, Cologne and Bologna; the four Funds have memberships ranging from 160 to 1,200 persons each; the insured persons pay between thirteen per cent. and thirty per cent. of the total cost of the insurance, the deficit being met by contributions of private persons and municipal subsidies.

In August, 1901, the city of Ghent, Belgium, adopted the plan of increasing, under certain conditions, by fifty per cent. the out-of-work benefits paid by the trades unions of the city to their members. The plan has met with favor in other localities and is used by the city of Dijon, France, and the province of Liege, Belgium. About 13,000 persons are now insured under this system.

*Municipal Government in the Philippines:* Clarence R. Edwards, Chief of Bureau of Insular Affairs, War Department, Washington.

The institution of local self-government in the Philippines has given the most practical evidence of the beneficent intentions of the United States. Under General Henry W. Lawton, the important town of Baliuag, immediately on its capture in May,

1899, was permitted to hold a public meeting and elect a captain municipal, or mayor. The plan of electing local administrative officials at town meetings was extended during the next few months to Santa Ana, Pandican, San Pedro, Macato, Pasig, Patero, Malabay, Paranque, Los Pinar, Bacoor, Imus, San Felipe Neri and a few others. The success of this experiment led to the installation of similar municipal governments in towns that subsequently passed under American control.

Owing to the conditions existing, some control over the local governments by army officers was necessary, especially in financial matters, but that control was gradually lessened until it became little more than advisory. While in some cases the municipal officers elected were in active, though secret, sympathy with the insurgents, many were assassinated because of their loyalty to the United States.

In 1900 a general order (No. 40) was adopted, applicable to any town in the archipelago, substituting for supervision by local commanding officers the right of appeal to the military district commander. It also provided for election by ballot and for limitation of the franchise. That order was subsequently modified by the municipal code, promulgated by the Taft Commission and is now the municipal organic law of the islands. The code extended the franchise, required expenditure for public schools, restricted the forms of local taxation, and provided for a centralized system of collecting the revenues. The early success of liberal and progressive local self-government prepared the way for the civil government now auspiciously instituted.

The following papers were read by title:

*The Progress of Irrigation as disclosed by the Returns of the Twelfth Census:* F. H. NEWELL, Hydrographer, U. S. Geological Survey, Washington.

*Progress in Insurance Engineering:* EDWARD ATKINSON, Boston.

*The Practical Handling of Woodlands:* GIFFORD PINCHOT, Forester, U. S. Department of Agriculture, Washington.

*Public Protection of Private Savings:* JAMES H. BLODGETT, U. S. Department of Agriculture, Washington.

*Local Life by Local Time, Expressed in Standard Time:* EDWARD S. WARREN, Newton, Mass.

*Voluntary Associations Among Cuban Working People:* VICTOR S. CLARK, Washington.

*Social Bacteria and Economic Microbes, Wholesome and Noxious: A Study in Smalls:* EDWARD ATKINSON, Boston.

*The Formative Period of a Great City: A Study of Greater New York:* WILLIAM H. HALE, Brooklyn.

FRANK R. RUTTER.
*Secretary.*

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## SCIENTIFIC BOOKS.

*Die deutschen Universitäten und das Universitätsstudium.* Von FRIEDRICH PAULSEN. Berlin, Verlag von A. Asher & Co. 1902. Pp. xii+575.

Professor Paulsen aims in his new book to give a systematic account of the nature, function, organization and historical development of the German university. Owing to the exalted position which the German university occupies in the world of education, and the universal nature of the problems discussed by Professor Paulsen, his work will be of value not only to his own countrymen, but to persons interested in the subject everywhere. It ought to be studied by every man who takes any part in university legislation, whether as president, professor or member of a controlling board, and by every student who desires to get the most out of his university course. It is so rich in valuable information, so full of practical suggestions, that it cannot fail to prove

useful and helpful to all who sincerely desire to perform the tasks growing out of their connection with university life, in the best possible manner. Particularly in this country where things are in the transition state and where, in spite of much that is crude and charlatanical, the desire is strong to assimilate all that is good in the higher institutions of other countries, will a work like this assist us in finding the right path.

After an introductory chapter (pp. 1–11) in which he describes the general character of the German university and contrasts it with the French and English types, the author divides his subject matter into five books. In the first (pp. 15–82) he traces the historical development of the German universities from the Middle Ages down to the present time. Professor Paulsen is fond of historical surveys of this kind, which help us to see things in the proper perspective and enable us to give them the right values. Such a study of growth will show us Americans how primitive many of our conditions are, and at the same time inspire us with the hope that they must pass away. In Book II. (pp. 85–200) Professor Paulsen discusses the present organization of the German university and its place in public life, its legal status, its relation to the State, to society and to the Church. Among the interesting subjects taken up here are: The legal relations of university teachers, salaries and fees, the filling of professorships, the legal status of private docents, the education of women, university extension, the position of university men in society, the protestant theological faculties, the catholic theological faculties, the participation of the different religious sects in university study. Book III. (pp. 203–335) is devoted to the university teacher, university instruction, and *Lehrfreiheit,* considering subjects like the following: The system of private docents, the personal relations between teacher and student, the lecture system, seminars and exercises, exercises for beginners, medical and scientific institutes, university pedagogy, theology and *Lehrfreiheit,* philosophy and *Lehrfreiheit,* the political and social sciences and *Lehrfreiheit,* the professors and politics, the university's function with respect to political education and public life. Book IV. (pp. 339–488) has to do with the student and 'academic study,' discussing, among other things, the significance and dangers of academic freedom (in the sense of the freedom of student life), preparatory training, the course of study, the elective system (*Lernfreiheit*) and the 'compulsory' system, the length of the university course, vacations, selecting and changing one's university, the objects and the means of university study, how to read and how to work, general culture, examinations, state examinations, the student and politics, the social mission of university students, and student societies. While the preceding book will serve as a guide to the university teacher, this book will be found to be particularly helpful to the student, bringing system and order into his academic life. In the last book (pp. 495–562) the different 'faculties,' theology, law, medicine and philosophy, are carefully reviewed and their aims described. It gives one an insight into the nature of the different 'faculties' or schools, as we often call them, and of the professions for which they provide the training.

Our country has learned much from the German universities, and it is largely owing to this that we occupy the position in the scientific world which we already occupy. It is safe to say, however, that we still have a great deal to learn, and that a book like Professor Paulsen's can point the way to new ideals. We have not yet reached the development of which we are capable. For one thing we have not yet reached that degree of inner freedom which the German university enjoys and to which Professor Paulsen attributes the wonderful advance which has been made in higher education in the nineteenth century. The one-man power, which exists in many of our institutions, the interference of governing boards with purely academic matters which should be left to faculties or individual teachers, the influence of politics and sectarianism, the unhealthy pressure sometimes exerted by the fear of losing appropriations, all these are problems which have not yet been

wholly solved, but which must and will be solved before the American university will become what it can become. Of course, this absence of inner freedom of action is often due to the primitive condition of many of our universities or to the fact that many of them are in the transition stage from college to university, and will disappear as these institutions more closely approach the university ideal. But whatever may be the causes and excuses for these conditions, the truth is there is more 'paternalism' in the universities of this 'free' country than in those of military Germany. There are dangers connected with freedom, very true, but these dangers cannot be avoided and are the price we must pay for the blessings of liberty.

Another element of strength of the German university, one that could not develop without the factor just mentioned, and without which the university could never have reached its present status, is the spirit of investigation among its members. The German professor is, above everything else, a scientific investigator. This phase of development also has its shadow sides and dangers, as Professor Paulsen shows. But it is true, nevertheless, as he says, that the position which the German people at present holds in the scientific world, it owes in the main to its universities, and these owe what they are and what they accomplish to the principle on which they are based: they are scientific institutions and their teachers are scientific investigators. And that is just exactly the goal at which our own best universities are aiming—in spite of the protests of small colleges that do not see that the function of the university is not identical with that of the college—and why they are beginning to inspire respect in foreign lands.

It would, of course, be impossible to touch upon all the interesting topics taken up by Professor Paulsen, within the narrow compass of this review. The most vital questions of university education are discussed by the author in his usual sensible, quiet and sane manner. He tries to see the things as they are, their good and bad sides, and he speaks as one who knows. His remarks on the lecture system, which, when supplemented by seminars and practical exercises, he regards as the best, on the whole, and his views on the elective system (*Lernfreiheit*), will prove helpful to many of us, at the present stage of our development. His defense of the German system of appointing professors, which is frequently attacked in Germany, is also interesting. The German plan is not perfect, of course; no system can be perfect that is applied by imperfect human beings, and illegitimate influences will always play their part in the selection of professors as long as human nature remains what it is. At the same time, it seems to me, the Germans are much more careful and impartial in their choice and maintain a higher standard than we do. Local, personal, political and sectarian influences are stronger with us than with them. It is true also that we are making great improvement along this line, and that the results are seen in the greater efficiency of our faculties, but appointments are frequently made in the United States, even in good universities, which 'outsiders' do not understand and the initiated understand only too well. We shall outgrow all that too, but we have not outgrown it yet.

This book of Professor Paulsen's is, in my opinion, the most satisfactory exposition of university problems and the most helpful practical guide in solving them that has been published in recent years, and cannot fail to find an appreciative circle of readers. It will bear good fruit in our country and increase the debt of gratitude which we owe to the German universities for what they have done for our higher education.

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## *DISCUSSION AND CORRESPONDENCE.*

### 'SO-CALLED SPECIES AND SUBSPECIES.'

THE article in the issue of SCIENCE for August 8 (N. S., Vol. XVI., pp. 229–231), under the above caption, is opportune, even if the author falls somewhat short of hitting the mark. He appropriately takes as his text Mr. Oberholser's recent 'Review of the Larks of the Genus *Otocoris*,' and presents the layman's view of the deplorable addition of a number

of new trinomial names 'to our already overburdened nomenclature.' Mr. Clark has done good work in certain ornithological lines, for which he deserves due credit, but his labors, so far as his published writings show, have been quite foreign to the subject upon which he here descants with the confidence becoming only to an expert. His statements and point of view, however, show lack of experience and familiarity with such lines of research as are involved in the consideration of trinomials and 'so-called species and subspecies.' Evidently he has never attempted to analyze and classify 2,150 specimens of larks, or of any similar varied and widely distributed group.

I am not writing to defend the work of Mr. Oberholser or of Dr. Mearns, which Mr. Clark has chosen as a subject for comment; nor to approve of the tendency of fine splitting now so much in vogue in certain quarters; but to correct certain unwarranted impressions that the lay reader may derive from Mr. Clark's statements and criticisms. Mr. Clark says: "The important question which this (Mr. Oberholser's) monograph raises is how far is it desirable to recognize these varieties (of larks) by name? Or better, are the diversities of size and color in a specified geographical area, sufficiently constant to warrant recognition as subspecies?" These are old questions, already many times discussed. The first question of 'how far,' etc., will ever be a matter of personal equation and temperament; in reply no hard-and-fast line can be laid down; so long as there are ultraists and conservatives, so long will there be 'splitters' and 'lumpers.' To the second question only an emphatic *yes* is admissible; and in Mr. Clark's contention to the contrary he affords conclusive evidence that he is writing without possessing that familiarity with the facts of the case which can only be attained by long experience in a field which is yet obviously little known to him. This is evidenced by the following, among other statements he makes: "To many persons it would seem to be almost an axiom that a character which can not be stated in language or in figures of any sort is not sufficiently conspicuous to bear the weight of a name." "Another rule which to the layman would seem to be axiomatic is that characters which can not be recognized regardless of the locality where the specimens are collected are worthless." This is naturally the layman's view of the case, but what are the facts, as known to the expert?

In ornithology, and especially in mammalogy, perfectly 'good species' are often so similar in size and color that even the expert cannot satisfactorily identify them from descriptions, and hence, almost from time immemorial, direct comparison with authentic material has been necessary in order to settle such difficult cases. As all experts in this line of study well know, forms that may be indistinguishable by descriptions are, when brought together, and especially when series are compared, so noticeably different that there is no trouble in distinguishing them at a glance. They present to the eye differences that are sufficiently impressive but which, owing to the imperfection of descriptive terms, cannot be adequately expressed in keys or in diagnoses. Hence when new material comes to hand from localities the fauna of which is as yet imperfectly known, the expert feels compelled, in a greater or less number of instances, to appeal to his confrères for the loan of authentic representative specimens of the described forms to which his own doubtful specimens seem most closely allied. Nor is it any disgrace to the expert, nor any reflection on present-day methods that constant resort has to be made to such aids.

As Mr. Clark very truly says: "The chief value of systematic zoology lies in its service as a basis for progress in knowledge of the laws of distribution, variation and evolution. Recognition of well-defined subspecies is essential to accurate knowledge, but bestowing names upon all sorts of individual diversities and inconstant trivialities is the very worst extreme." And, after quoting some very 'sensible words' on this point from Mr. Oberholser's paper, he goes on to ask "* * * but can degrees of variation be properly set forth if they cannot be 'intelligibly expressed on paper'?" We submit that the 'layman,' who is naturally so troubled and confused by the modern ways of finding out how and to what

extent animals are modified by their environment, is not the proper arbiter to determine the value and bearing of expert knowledge. If in other fields of scientific research it is not demanded that the investigator stop his work at the point where his results are within the comprehension of the lay mind, why should the student of birds and mammals be expected to refrain from extending his researches beyond the point of convenience for the layman?

Mammals, being sedentary, are very susceptive to climate or other physical influences; birds being to a greater or less extent migratory, are perhaps, generally speaking, less so although when non-migratory they respond, often with great readiness, to environmental influences; but in the case of non-sedentary species, the fact of migration, combined with the ever-varying seasonal conditions of plumage, increase the difficulty of discriminating and geographically limiting localized forms. The factor of intergradation between neighboring forms over areas connecting the main differentiation regions also complicates the problem of identification and leaves a considerable proportion of connectant specimens that cannot be satisfactorily referred to one rather than to another of two or more geographically adjacent forms. But this is as it should be, if environment has any influence in modifying animals. The real trouble is the temptation to indiscreet or over-ambitious specialists to give names to too many connectant forms that would be better left unnamed.

Experience shows that the 'characters' claimed by describers for their new forms are rarely without basis; when the same material is independently examined by several different experts they generally agree as to whether or not certain alleged differences exist, but they may, and often do, differ in their estimates of the nomenclatorial value of the differences. This, as before intimated, is a condition of things beyond present remedy. As regards North American birds, the aspiring young ornithologist has now a comparatively barren field so far as the discovery of well-marked new forms is concerned and the tendency is to name forms not fairly entitled 'to bear the weight of a name.' His 'discoveries' are often not new zoological facts, but a reestimate of the nomenclatorial value of facts long known to the older, more experienced, and more conservative workers, who have simply not deemed them entitled to serve as the basis of a name. But there are many exceptions; as material collected in the breeding season from many and widely separated regions becomes available for comparison, it not infrequently happens that differences previously unnoticed, or if noticed incorrectly attributed to seasonal or individual variation, are found to have a local habitation and to characterize distinct geographic areas. Although such differences are commonly slight, at least from the layman's point of view, they are zoological facts that may well be recognized by making them the basis of a name.

In this connection it may be well to recall the fact that not all of the many new 'subspecies' of North American birds proposed in recent years are admitted to recognition by the American Ornithologists' Union Committee on Nomenclature, whose duty it is to examine the merits of each and rule upon their admissibility to the A. O. U. 'Check-list of North American Birds'; at least one third having been 'turned down' or disapproved by the A. O. U. Committee, while many more are still in abeyance awaiting further investigation by the Committee. But the adverse ruling of the Committee does not always result in their effectual suppression, as their authors, with a small personal following, sometimes continue indefinitely to recognize in their own writings some at least of the discredited names.

As already said, Mr. Clark's article is timely and voices a widespread feeling among laymen, but who, it is not too much to assume, are necessarily poorly equipped to render a proper verdict in a field where expert knowledge is necessary. Yet it must be conceded that the laymen are in part right; 'splitting' is undoubtedly carried too far, and that the fact is well recognized, and the practice esteemed a great evil by competent judges, is evidenced by the decisions made each year by the A. O. U. Committee. On the other hand Mr. Clark's presentation of the case, if allowed to pass without comment, might lead to erron-

eous inferences, prejudicial to a correct understanding of what is really taking place and to the setting up of wrong standards in respect to the degree of difference legitimately open to recognition by name. J. A. Allen.

PRESIDENT MINOT ON 'THE PROBLEM OF CONSCIOUSNESS IN ITS BIOLOGICAL ASPECTS.'*

Sciences, like human beings, are seldom indifferent to the good opinion of others. Even age and great respectability never wholly dull the moral consciousness of a science to the approval and disapproval of its neighbors. This sensitiveness is, however, keenest and most easily wrought upon in the younger sciences, for the reason that these are most frequently challenged to defend their right to exist. Self-consciousness—provided it does not approach morbid embarrassment—is by no means a misfortune to the youthful science. It clears up its concepts, gives self-confidence and helps it to get on with its fellows. Psychology has had, more than most sciences, to give a strict account of itself and of its methods, both because it has had an unusual amount of prejudice to overcome and because it has developed in an unusually critical and criticising period of thought. The social pressure has, however, served its purpose, so far as psychology is concerned; for psychology —even as an experimental science—has passed its majority and knows perfectly well what its task is and how it means to perform it. But, while this is true, and while one science is never, within its own borders, responsible to any other coordinated branch of knowledge, there is, as I have intimated, the temptation to stop and listen when one's character and obligations are discussed in a convocation of the sciences. The temptation is not to be withstood when the discussion turns out to be the authoritative opinion of a near neighbor with whom important and amicable relations have, for some time, been sustained. Professor Minot, in his recent address at Pittsburgh, indicates what he conceives to be the most natural and the most profitable attitude of the biological sciences toward psychology. His outline involves a definition of mental phenomena, a statement of the part that consciousness plays in bionomics, and an appeal to psychology to employ the comparative method. The argument of the address runs as follows:

Consciousness may be regarded either as a real phenomenon in the world or as an epiphenomenon. The 'epiphenomenon hypothesis of consciousness' is, according to the author, 'an empty phrase, a subterfuge.' "Consciousness ought to be regarded as a biological phenomenon, which the biologist has to investigate in order to increase the number of verifiable data concerning it. In that way, rather than by speculative thought, is the problem of consciousness to be solved, and it is precisely because biologists are beginning to study consciousness that it is becoming, as I said in opening, the newest problem of science." * * * "For the present, it is more important to seek additional positive knowledge than to hunt for ultimate interpretations." The 'younger science of experimental psychology' is, therefore, to be welcomed. "It completes the circle of the biological sciences." The most striking peculiarity of consciousness—a peculiarity which is common to biological processes—is that it is teleological. "We do not know what it is, we do not know how it functions, but we do know why it exists." The essential 'function of consciousness is to dislocate in time the reactions from sensations.' The evolution of consciousness is a strong indication of its usefulness to the organism. If it had not been useful it would have disappeared. It is useful because it permits the individual to react on his accumulated experiences. Sensations recur in memory and increase the scope of possible adjustments. Sensations are only symbols of 'objective phenomena.' We 'see' colors, but light—the 'external reality'—is undulations. "Objectively, red, yellow and green do not exist." These symbols are, nevertheless, convenient labels, for by means of them the individual reacts appropriately on every occasion. They are 'bionomically sufficient because they are constant.' 'They enable consciousness to prophesy or foresee the results of the reactions of the organism,' and, hence, to maintain adjustment. Animal conscious-

* Science, July 4, 1902.

ness is a homologue of human consciousness. Its function is the same. Consciousness must be posited at least as far down as sense organs and nervous systems are to be found. These considerations lead to the conclusion that 'the development and improvement of consciousness has been the most important, really the dominant, factor in the evolution of the animal series.' Sensory and motor organs have multiplied for the sake of consciousness; to supply it 'with more possibilities of adjustment to external reality.' Since mind is teleological, it must be primary, and reflexes and instincts derivative. Through habit, consciousness sometimes lapses—for the sake of rapidity in reacting—and reflexes and instincts take its place. If mind has been the most important factor in the evolution of the animal series, 'the necessity of treating consciousness as primarily a problem for biological research to solve' is obvious. The 'psychologists ought now to apply the comparative method on a grand scale.' Psychology is extremely backward; but with the new method we may come 'to the understanding of even consciousness itself.' Consciousness is not a form of energy; it is as ultimate as force, or energy; but it 'has the power to change the form of energy.'

There is little doubt that Professor Minot's plea for a closer alliance between biology and psychology will be seconded, heartily, by many biologists. The advantage promised to the sciences of life is certainly alluring. It is true that the alliance proposed would affect a comparatively small part of the field of biology—that part of zoology which deals with the descent of the higher animal forms—and, likewise, a comparatively small part of the field of psychology. Even if we grant that consciousness has as wide a range as the author maintains (many investigators in both sciences would make the limits much narrower), there is only a portion of one problem in one of the great subdivisions of biology that can hope for direct aid from psychology. Nevertheless, no one can deny either that the problem has enormous proportions or that the promised aid is worth acquiring. As for the other science involved, psychology frankly recognizes the importance of studying mental development. But she can scarcely consider incidental aid to be rendered another science a sufficient excuse for abandoning her work in general in order to solve a single problem.

But, again, let us see whether the biologist's demand for consciousness is as urgent as it appears to be. Even though he admit mind as a factor in evolution, he is not thereby relieved from considering the development of the nervous system as a likewise important factor. He will hardly deny that a complex and highly differentiated nervous mechanism is an advantage to the organism. If he deny this, what becomes of his argument for the usefulness of surviving organs? If man stands high in the phylogenetic series because he has a good mind, he also—by the same argument—stands high because he has a good brain; a brain that affords him more complicated and appropriate reactions than other animals can compass. And why not go a step further? Since there is no question, either in psychology or in biology, that new mental functions imply new nervous apparatus, or at least new nervous functions, why should the biologist duplicate his factors and posit a double cause for a single effect? If mind 'dislocates' sensations in order to unite the past and the present, the brain—much more literally—preserves a dispositon to functionate as it has already functionated, and thereby brings profit to the organism. If consciousness 'lapses' and is replaced by reflexes, in order to insure more rapid adjustment, neural functions cut corners, follow lines of least resistance and become simplified to the same good end. If one sensation 'inhibits' another—a dubious doctrine!—activity in one part of the cerebrum undeniably checks activity in another part of the cerebrum. It is natural that the biologist should make excursions into psychology when he stands in temporary need of links which are missing to his phylogenetic chain of causes; but if he wishes to make consciousness 'the dominant factor in the evolution of the animal series,' he should first show that consciousness contributes something to descent that is not contributed by the physical processes underlying consciousness. When

he has done this and has settled accounts with energetics—for introducing an element which is not energy, but which changes the form of energy—he will be ready to launch his theory of psychophysical causation. He may, even, found a science of psycho-bionomics, which shall stand in precisely the same relation to psychology and biology that psychophysics now stands to psychology and physics.

This last point raises, very naturally, the question of the scope of the biological sciences, a question that has been so often discussed that one is inclined to apologize for raising it. However, Professor Minot's two-fold assumption that 'scientific psychology' is one of the 'great divisions of biology' and that 'the biologist must necessarily become more and more the supreme arbiter of all science and philosophy,' is sufficient excuse. The first part of the assumption is largely a matter of definition and need not distress the psychologist who shrinks from being lost in a vast science of life. If biology can be made to cover all systematic knowledge of the whole—the psychophysical—organism, then it includes psychology; but if it continues to cover the structures, the functions and the histories of organic bodies, then, just as surely, psychology lies outside biology. The choice rests on the likeness or difference of subject matter and the likeness or difference of method. The subject matter of psychology is, as Professor Minot admits, unique. Consciousness is as ultimate as force. As for method, no psychologist with reliable instincts ever does confuse his method with the method of the embryologist or the physiologist, any more than he confuses it with the method of the physicist. He may and does (when it suits his purpose) use —as the author advises—the 'comparative' method, which is 'method' in a narrower sense. So do the historian and the geologist; but they are not, for that reason, accused of writing biologies.

The contention that the biologist must become the 'supreme arbiter' because 'human knowledge is itself a biological function' is a challenge to the epistemologist rather than to the psychologist. The epistemologist will not, I imagine, find it difficult to prick the vulnerable point in the argument. He may, perhaps, reduce the claim to an absurdity by insisting that it makes biology the universal science as well as the only true philosophy, or he may show that the contention is itself a *petitio*, because it assumes but cannot, so far as it is—as a bit of knowledge—a mere function, stand warrant for its own validity. It is good Baconian doctrine to advise, 'observe more and more and in the end you will know. A generalization is a mountain of observations, from the summit the outlook is broad.' But one does not quite see why it is the biologist—of all the normally functioning organisms in the world!—who is capable of generalization; why 'we must look to biologists for the mighty generalizations to come.' Does, then, the biologist monopolize the function of knowing as well as the study of that function? Or is this only a specific application of the advice, 'know then thyself'? The argument is not quite clear on this point. And, as for the observations, a mountain can neither see itself nor its surroundings. If observations could give their own systematic setting, we should be more inclined to hold them to account when they form a mere heap of dry facts set in a waste of words. As the author says much more truly in another connection, 'our mental wealth * * * consists of the thought into which the data of observation are transmitted [transmuted?]' rather than in the observations themselves. We may take it for granted that Tyndall's 'Tories' in science, who look upon 'facts' as alone having value and who 'regard imagination as a faculty to be feared and avoided rather than employed,' are an extinct class and that even 'deep meditation' is indispensable alike to science and philosophy. On the other hand, the command to 'observe more and more' will scarcely find a heretic to resist it in these days of loyalty to science. I cannot speak for biologists, but I am sure that I can speak for psychologists—the class to whom Professor Minot especially directs his exhortation. Thirty years ago, psychologists left off searching for the ultimate nature of mind and began to clamor for actual knowledge about mental experience. Long since, the tendency to 'observe' has become instinctive,

and for this reason, and this reason only, it is seldom discussed.

The author says that 'the results of experimental psychology are still for the most part future,' though we may even now 'obtain some valuable preliminary notions concerning consciousness from our present biological knowledge.' The statement can be accepted only if one disregard the mass of psychological material that has been collected since Fechner wrote his 'Elemente der Psychophysik,' Helmholtz his 'Physiologische Optik' and 'Tonempfindungen' and Wundt his 'Grundzuege der physiologischen Psychologie.' With a current literature of approximately three thousand titles in the year, a literature that covers every phase of consciousness, with hundreds of trained workers who are making observations in scores of laboratories the year round, it is plain, at least to any one within the science, that disregard of the injunction to observe is not psychology's ruling vice. As for the attitude toward mind that psychology should take —that is, naturally, a problem which the science must solve for herself. For herself, because psychology's first business is to know mind quite apart from any special use that any other discipline—biology, pedagogy, sociology —may wish to make of mental phenomena. A science must choose her own way; a *vis a tergo* from a well-wishing friend can only cause her to stumble.

More specifically, the president's address urges a genetic study of mind because the 'why' of mind, its teleological function, can be investigated with profit while the study of 'what it is' is 'recondite, metaphysical, and carries us beyond the limits of verifiable human knowledge.' The force of this argument depends entirely upon what one understands by 'why' and 'what.' There is, surely, a scientific 'what' as much as there is a scientific 'why'; and there is as truly a philosophical 'why' as there is a philosophical 'what.' The morphologist and the analytical chemist ask 'what.' They deal with structure. On the other hand, the biologist is answering a 'why' when he explains that mind exists for the sake of the body's 'adjustments to the external conditions' and that the body exists—at least 'a large part of our anatomical characteristics exist for the purpose of increasing the resources of consciousness.' Mind for body and body for mind! That is a game of teleological 'tag' that is neither 'recondite nor metaphysical.' But should the biologist ask 'why adjustment at all?' 'why evolutionary process?' 'why not being without becoming?' he would find himself as far outside his science as is the hypothetical psychologist who is concerned with the question of the ultimate nature of mind. Surely, observation is, first of all, looking for what is 'there'; 'there' for psychology in one's own consciousness, in the consciousnesses of one's fellows and, later, in the consciousness of the child, the animal, the abnormal, the savage. It is safe to assert that no one can point to a single piece of successful genetic work in psychology which is not based upon a more or less adequate study of 'what consciousness is' in the human adult. Indeed, this must be the case. The development of a thing cannot be described correctly until the thing itself is known. It is, one may admit, not difficult to construct hypothetical consciousnesses for the amœba, the jelly-fish, the bee and the beaver; consciousnesses which shall explain beautifully the reactions of these animals. But the question arises whether these hypothetical minds really exist. Oftentimes they do not. The recent history of genetic psychology is filled with fictitious minds which are worse than useless to the psychologist, whatever their value may be to the biologist. One proof of their unsatisfactoriness, even as agents of natural selection, is given, I am inclined to believe, in the well-marked tendency within biology to explain reactions of the simpler organisms in terms of 'tropism' and 'taxis' instead of in terms of 'volition' and 'reason.'

The question of the 'epiphenomenal' nature of mind has little interest for the psychologist. 'Epiphenomenalism' or 'automatism' is not a psychological concept. Huxley introduced it into biology to show that biology has no real concern with consciousness, since consciousness—as he affirms—does not react causally upon the body. Psychology rejects the term 'epiphenomenon' not because it denies a

causal relation between mind and organic processes—a majority of psychologists, perhaps, refuse to admit such a relation—but because it implies that there is a great gulf fixed between 'real' things in the world, phenomena, and epiphenomena, the conscious 'foam' of existence. For the wide use of the term, modern biologists must surely share responsibility with modern monists. It will interest the psychologist, even if it does not instruct him, to hear from biology the authentic statement that 'consciousness is too familiar to all men to be summarily cast aside and dismissed.' But, for psychology, mental facts are not a whit more important or more valuable if consciousness turns out to have a survival value. They are important to their own science just because they are a body of facts of experience that are capable of being worked into a system. The argument from the survival value of consciousness—an argument that has had at least twelve years of popularity—gives, it will be generally admitted, some support to the position of the interactionist. But however relevant the argument may appear to biology, it does not persuade the psychologist that the facts of consciousness are one iota more real or more important than he had before considered them to be. Even though he adopt the theory, he will find no reason for making a radical change in his attitude toward mind. Hence, should the very most 'essential function' of consciousness prove to be the 'dislocation' of reactions, it is biology and not psychology that will need to be apprehensive of the effect upon the organism of so serious a luxation.

There is one further point in President Minot's address that I shall venture to criticise, although it is more a matter of general methodology and of the science of knowledge than of psychology. In reviving the argument that sensations are symbols, labels, not images; that 'external reality' is a 'series of undulations' or a series of 'vibrations of the air' and not colors and sounds, which have no 'objective' existence, the author falls into the ancient fallacy that, somehow, men can be conscious of an external world that is 'screened from' consciousness. The fallacy appears here in an aggravated form. The 'dislocation' argument implies that consciousness is made up of sensations, but sensations have no objective reality, and yet we know through sensations—thanks to the 'biological study of consciousness'—'that the objective world is real.' If we grant that the concepts of any single science may be taken as representing the 'real' world, we may still ask why the exceptional honor should be done to physics when it is the biologist who 'must necessarily become more and more the supreme arbiter of all science and philosophy.' Why should the biologist, when he is casting about for a real world, adopt the 'doll-idea' of the physicist? Perhaps it is done in return for the service which physics—by the loan of her 'real' undulations—has rendered biology in settling 'the debate in favor of the view that the objective world is real.' But the logic of the article seems to require that the most real thing be an organic reaction, or an adjustment, or the evolution of species, and not a disturbance of the air or the ether. However, if —as President Minot urges—all science is, after all, 'symbolic' as 'all sensations are symbols of extreme reality,' why should we 'make believe' in the reality of any of her ideas? If sciences as well as sensations display a 'peculiar untruthfulness to the objective,' why deceive ourselves with 'pseudo-opinions' —why 'come to fight with shadows and to fall' —when 'behind in consciousness' there 'is the sense of unreality'? The practical advantages of getting on in the world, of 'prophesying' the results of reactions, will hardly atone for so gross a self-deception.

Science, as well as popular belief, still cherishes its *pseudodoxia epidemica*. Of these, none is more amazing than the claim of a single science to hold the quintessence of human knowledge; to stand as the 'supreme arbiter of science and philosophy.' One expects to find this lack of perspective in the various forms of occultism, but one is inevitably dismayed to find it in science. The various borders of knowledge everywhere overlap. Were this not true, hope of ever knowing the cosmos would be vain. As a consequence, there will always be the possibility of dispute

over the relations of one discipline to another. But this ought not to hinder any science from setting its own limits and doing its own work, while it accepts all the aid it can get from others. No science is more widely indebted than is psychology; but psychology demands, no less than others—such is scientific selfishness!—that she be allowed to work out her own destiny in her own way.

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## SHORTER ARTICLES.

### THE SALT MARSH MOSQUITO, CULEX SOLLICITANS WLK.

IN SCIENCE for January 3, 1902, p. 13, under the caption 'Concerning Certain Mosquitoes' I pointed out that *Culex sollicitans* was the dominant form throughout a large portion of the State of New Jersey. Upon our ability to control this species depended the riddance of the State to any notable extent, and the life cycle of the species became, therefore, a matter of the greatest importance. I suspected even at that time that this species departed materially from the stock history given for *Culex* and assumed for this species; but my observations had been sufficient only to suggest the need of closer study. I showed at that time that, by breeding in salt water and by migrating for long distances the species had distinctive characters. And, bye-the-bye, there is no more perniciously erroneous popular statement than that mosquitoes do not fly far from the place they were bred. It is absolutely untrue of most of the species and not entirely true of any. The only case where it is practically true is where a species is limited in its breeding places, *e. g.*, the species that breeds only in the leaves of the pitcher plant. Of the salt marsh mosquito it is conspicuously incorrect.

In February and March I started a hunt for the adults on the supposition that the female hibernated. My assistant, Mr. Dickerson, searched every nook and cranny that might shelter a mosquito in a seashore locality where, during the summer, the insects had driven out all guests. *Culex pungens* and *Anopheles* were found in numbers; but of *sollicitans* not one! I had no better luck when I took up the search myself, and even a reward offered to the natives for every specimen brought to me, failed to produce returns. I concluded, therefore, that the insects did not winter in the adult stage and began a hunt for larvæ. I knew that *Aedes smithii* wintered in the larval stage and that the wigglers would stand repeated freezings. But I failed also to find larvæ in the very regions where they were abundant in 1901, and where I had also seen them in 1900.

A wintering in the egg stage was unknown for *Culex,* but I was driven to that alternative and watched carefully for 'signs.' They came as the water warmed up. First, larvæ were found in pools high up which had been filled by the winter tides. The temperature of the water was distinctly higher than that of the air in the morning and evening and several degrees higher than that of sea water. Area after area became populated and there were millions of larvæ, growing very slowly, before a solitary mosquito was seen. A hibernation in the egg stage seemed obvious; but I ran against the fact that some of the areas swarming with larvæ were dry during the summer and fall of 1901 and became water-filled only during the winter storms. If the eggs hibernated on that ground they must have been laid on dry soil or on the grasses! This then was the point to which I had arrived at the opening of the breeding season. College duties and other matters prevented a resumption of the work until July 7, when Mr. Dickerson and I spent a week at Five Mile beach; I kept him in the field another week alone and rejoined him when the experiments were expected to produce results. Our outfit consisted of a series of seven tubs sunk into the marsh so as to project only a little above the level. In five of them was placed sod from the marsh and two were left bare. Sea water was placed in all save one of the tubs in varying quantities. Two tubs were left open—one with sod, one without; the others were covered with mosquito netting. Conditions along shore at this time were very dry and, breeding places were fast disappear-

ing. I secured, however, in some remaining puddles a large lot of larvæ and pupæ and placed these, in jars, under the covered tubs. Adult mosquitoes were present in great numbers and, with pools so scarce, it was supposed that the uncovered tubs would prove very attractive.

A series of glass jars was prepared with and without water, with and without grass, and captured females were introduced. In almost every case eggs were found after twelve hours; but as they were laid under all sorts of conditions, and black mature, as well as white immature, specimens occurred, it was obvious that this was only the natural tendency of a confined female to oviposit at all hazards. But it was of real advantage in that it gave us the egg so that it might be identified under natural conditions. In color it is polished black, pointed at both ends, almost perfect spindle-shaped from one point of view, a little curved or pod-shaped from another, half turned over. In length it is less than one millimeter.

While all these preparations were made by Mr. Dickerson, I explored the marshes round about and found, to my surprise, that this immense area which had been supposed to be the very breeding stronghold of this species was as a matter of fact perfectly safe. There were no mosquitoes at all on these great marshes and no larvæ were in any of the 'salt ponds' formed by natural or artificial methods; not until the edge of the upland was reached did I find either mosquitoes or larvæ. It goes without saying that if this immense area of salt meadow can be practically ignored in mosquito extermination plans, we have made a very long step toward the simplification of the problem.

Without going into details here it may be said that the evidence from the tub experiments was negative. Under none of the conditions artificially presented to them did the insects lay eggs. Yet egg-laying females were present in abundance and some were sent to New Brunswick by Mr. Dickerson about July 15.

From the dissection of these specimens I obtained the following record:

No. 1. Black eggs 46, gray eggs 17, white eggs 101; total 164.

No. 2. White eggs 117, and a little undigested blood in crop.

No. 3. Black and gray eggs only, 148.

No. 4. White eggs only, 135.

No. 5. Black and gray eggs 47, white eggs 35; total 82. It is probable that this last specimen had been ovipositing.

July 20, when the tub experiments were closed, all the evidence pointed to an oviposition on the sod, or in the dry bottom of old breeding pools. Material from dried up pools, old and recent, was obtained and examined carefully in basins. A few eggs were found almost everywhere, but not enough to make it at all certain that these were normal points for oviposition. Finally in our examinations we reached the sods of long marsh grass, forming the upper edge of a pool that was then and for a time had been entirely dry.

This sod was simply a mass of interlaced roots and on the surface was a layer of soft, black mud. In this mud I saw undoubted mosquito eggs in such numbers that I washed the surface into a basin and left the material until next morning. Then the basin was swarming with larvæ and the eggs must have been at the rate of from 50 to 150 on one square inch of sod.

After determining the place of oviposition the next questions were under what circumstances do the insects hatch and how long may they remain dry during the summer.

Two sods approximating six inches square were cut from the marsh and carried to New Brunswick, July 21. One sod was placed in a deep glass dish in the bottom of which was half an inch of water. The sod was two inches deep, so the surface was well above the water, which was renewed from time to time to keep it at about the same level. The other sod was put into a porcelain evaporating dish and left dry. It fitted loosely and air could get on all sides and under it. Absolutely no moisture was added at any time.

July 31, ten days after the sod was taken, a small piece—about two square inches—was cut off late in the afternoon and the surface mud was washed into a dish. Next morn-

ing 117 larvæ were counted and some of these were carried to maturity, so that the complete life cycle from egg to adult was under observation.

August 10, duplicated this experiment but began about 8 A.M., to determine the time of the appearance of the first larvæ. Before 10 A.M. the dish was swarming with wigglers; all the eggs had hatched in less than two hours.

On the same day I cut off a small section of the sod that had been kept continuously moist and washed this into a dish. Twenty-four hours later no larvæ had developed and I submitted the mud to close examination. Numerous eggs and egg fragments were found, making it certain that the absence of larvæ was not the natural result of the absence of eggs.

August 11, this last experiment was duplicated with the same result. The sod had been so wet as to induce development and perhaps hatching while there was no water to support the larva. The latter suggestion is due to the large number of broken eggs that were found.

August 12, Mr. Dickerson washed the mud from a small square of dry sod into a large dish and began transferring the eggs into a watch glass. It was a slow job because the black eggs are not readily differentiated from the black mud, and in about half an hour he began to find broken eggs. Transferring the watch glass from a white to a black backing he saw several pure white, minute wigglers, just out of the egg. Half an hour's submergence, then, was enough to start out the larvæ, and soon afterward it became impossible to find unbroken eggs. The piece of washed sod was placed in another dish and, an hour later, more larvæ were obtained. When the larva is ready to emerge, about one fourth of the egg lifts or breaks off, giving it exit. The small end may remain attached to the larger for a time by a sort of hinge; but it is detached by the least shaking of the water.

We have then, briefly, the following life history. The adult lays eggs, singly, in the mud of salt meadows above ordinary high tide and where the sod is not soaking wet. It probably lays them elsewhere as well, but I am stating the rule, as I believe. The eggs remain here an unknown length of time until an extra tide or a heavy rain covers them with water. The eggs hatch almost immediately and the larvæ find their food in the soft, decomposing mud. It makes little difference whether the water is fresh or salt, so long as the proper food is present. The stay in the larval and pupal condition varies according to temperature, but is not less than a week. The males emerge first and rarely, if ever, leave the immediate vicinity of the place of hatching. It is probable that copulation takes places soon after the female emerges, but I have made no direct observations, and have been unable to secure a pairing in captivity. It is also probable that the females do not fly to any distance until they have been impregnated and it is certain that there is no development of the eggs until the insect has fed. A long series of specimens collected as they came to the attack and afterward dissected, all showed an empty alimentary canal and undeveloped ovaries. Another series, collected by sweeping in the natural breeding places showed that wherever the ovaries were developing the alimentary canal showed food remnants, greater or less, according as the eggs were undersized or approaching maturity. When the eggs were fully developed the food remnants disappeared. So far as determined the food was blood in all cases; but of what kind was not made out. As the collections were made near a settlement, it might have been of horse, cow, dog or man.

I have already referred to the specimens sent on July 15. On the 20th I collected a lot of about 100 examples by sweeping, and examined for ova. Curiously enough, none of the examples had fully developed eggs. They ran all the way to full size, beginning to turn translucent as the shell became differentiated; but not a black egg was found. The number of eggs varied greatly, but rarely reached 200 and rarely fell below 125.

Not all the points of interest in the life cycle of the insect are covered, but enough is now known to understand the economic problem. We know that, so far as this species is concerned, all permanent water areas, deep or shallow, are safe. So are temporary pools in very wet salt meadows. All meadows covered

by ordinary tides are safe, and so are all those low enough to be attractive to fiddler crabs.

Areas covered by the monthly high tides are safe, except in midsummer if it has been dry enough to kill out the young fish and has then rained enough to fill the low places. The danger points are such as I pointed out in SCIENCE and more at length, recently, in Special Bulletin T of the New Jersey Agricultural College Experiment Station.

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August 20, 1902.

## 'LATENT HEAT' AND THE VAPOR-ENGINE CYCLE.

THE discussion, some time since published in SCIENCE, relating to the vapor-engines, so-called, and the 'latent heat fallacy' led to inquiries from various sources regarding the exact distribution of the work of thermodynamic transformation in the case of the steam, and other vapor-engines. The following may perhaps make clearer the relation between the action of sensible and of 'latent' heat in such cycles. The discussion of this problem has been one of the annual topics in the classes of the writer for years past.

The usual standard form of engine-cycle, in all departments of applied thermodynamics and with the steam, and other vapor-engines employed in the industries, is that known as the Rankine cycle with incomplete expansion, as in the figure. It consists of a line of constant maximum pressure, an adiabatic expansion-line, as nearly as practicable, a line of constant volume, a line of constant minimum pressure, and the cycle is closed by a line of constant volume. Assuming unit-weight of the working substance to be carried through such a cycle, it is easy, by the adoption of one of Rankine's beautifully ingenious mathematical devices, to obtain the following expression for work of one cycle in which $p$, $T$ and $u$ are the pressures, the temperatures, absolute, and the specific volume of the charge; $H$ is the latent heat of vaporization and $J$ is Joule's factor. The subscripts indicate, respectively, values of $p$ and $T$ on the expansion line and of $p$ on the back-pressure line:

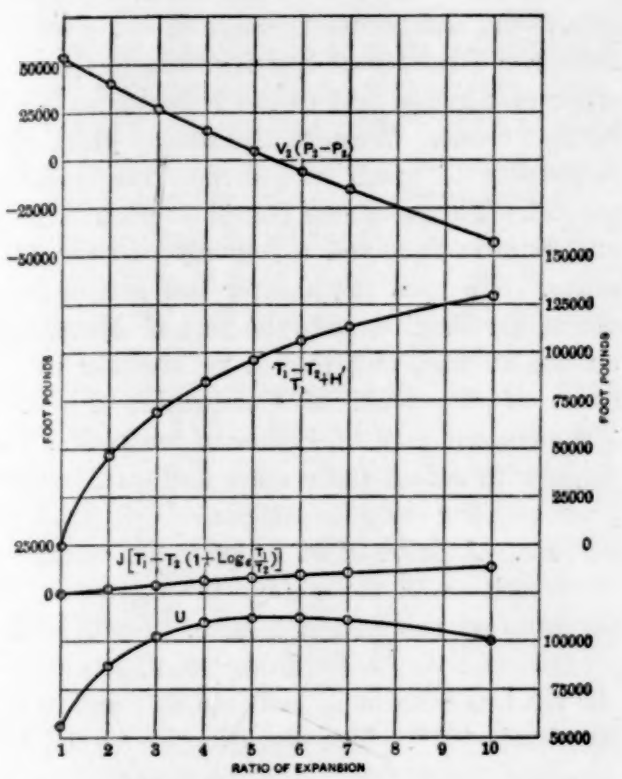
$$\begin{aligned} ABCDE &= AFG + ABCFA + CDEG \\ &= (\text{I.}) + (\text{II.}) + (\text{III.}) \end{aligned}$$

$$U = J[T_1 - T_2(1 + \log_e T_1/T_2)] + H_1(T_1 - T_2)/T_1 + (p_2 - p_3)u_3.$$

The three parts into which the measure of net work, $U$, divides itself are obviously a function of temperature which measures the effect of the thermodynamic application of sensible heat, a function of temperature and 'latent' heat which is instantly recognized as the measure of the Carnot efficiency of the 'perfect engine,' and a function of the terminal and back pressures and specific volume of the charge at the minimum temperature of the expansion-line. This latter is obviously, also, the work between the terminal and back-pressures, the rectangle, $CDEG$. The intermediate term is the work obtainable from the same quantity of fluid between the same two temperatures, $T_1$ and $T_2$, in the Carnot cycle, $ABCFA$, and it is thus evident that the first term must measure the remaining area of the Rankine cycle, the triangle, $AFG$; which is as evidently the work alike of the compression in the Carnot cycle and that of expansion of unit weight of a mixture of steam and its liquid between the state of liquid at maximum temperature at $A$ and that of mixed vapor and liquid at the lower limit of expansion pressure and temperature, $p_2$ and $T_2$.

Noting the proportions of the areas thus measured, it is seen that, with any fixed value of the latent heat of vaporization, the last-named quantity has a lower relative measure as the ratio of expansion and the temperature-range decrease, and, *vice versa*, that the quantity of work performed within the same temperature-range is in all cases greater in the Rankine than in the perfect engine cycle by this amount; that the work in either cycle is proportional, in some direct measure, to the quantity of the heat of vaporization; that the heat entering the fluid during vaporization is *all* converted into work and that none is employed to change temperature and thus to become stored as sensible heat. Observing, also, that the Carnot cycle is that of maximum efficiency, it follows that the work measured by the first term, and by $AFG$, is obtained at a comparative loss of efficiency and that, therefore, the work gained in the Rankine cycle,

per unit of working fluid, is secured at a loss of power per unit of heat supplied. It is still further to be seen that the greater, as well




WORK IN RANKINE CYCLES.

as the more economical, work-production is effected by the conversion of the so-called 'latent' heat of vaporization directly into mechanical energy or into work. It follows, still further, that the larger the quantity of 'latent' heat, the greater the work of a given weight of fluid and the lower the weight of water or other liquid per unit of power. Water has thus a double advantage in low expenditure per horse-power at a given temperature-range and efficiency of cycle, and in small, usually insignificant, cost.

These relations and the variations, especially, of relative magnitudes of the three terms with varying expansion-ratios from a given initial pressure, with, as is usual, constant back-pressure, in the ideal case, is well exhibited by the accompanying figure. This set of curves includes those of total work, of values of the several terms, and of relations of rate of variation, for such a case, in which the steam-pressure is about 7.5 atmospheres, the back-pressure one seventh that tension, and the ratio of expansion, ranging from unity upward, in an engine which would be ordinarily rated at about 200 horse-power, at 85 revolutions per minute with $r = 4$.

It is seen that the total work, $U$, increases rapidly from $r = 1$ to $r = 4$, passes a maximum at about 5 and rather rapidly falls off again, after the expansion-line begins to intersect the back-pressure line (curve $A$).

The work of sensible heat (curve $B$) increases slowly throughout the range exhibited, and substantially in proportion to $r$, and is, throughout the whole range, small in comparison with the work of 'latent heat' (curve $C$).

The work of the rectangular area below terminal pressure (curve $D$) is similarly variable, but becomes negative at the point of junction of the expansion line with the back-pressure line. Throughout the whole usual range of expansion in the real engine, this quantity is small in comparison with that measuring the second term.

The value of the second term, on $B$, is thus the principal element of the total work of the cycle and is larger, relatively, as the diagram approximates the form of the Carnot, rather than the Rankine cycle. The deduction at once follows that 'latent' heat, and latent heat only, so far as practicable, should be utilized in the thermodynamic transformations of the vapor-engines.* The 'latent heat fallacy' is thus clearly disposed of.

A similar investigation would show that, in the gas-engines, the 'latent' heat of isothermal expansion, rather than the sensible heat producing change of temperature, should be utilized in thermodynamic transformations and the production of power.

The final conclusion is thus obvious that maximum efficiency of thermodynamic engines can only be secured by the utilization, solely, of 'latent' heat.

R. H. THURSTON.

## ON BACUBIRITO, THE GREAT METEORITE OF SINALOA, MEXICO.

FOR more than a century the meteorites of Mexico have attracted attention and record.

* 'Manual of the Steam-Engine,' Vol. I., §112, pp. 437–438.

In his great work on 'La Nouvelle Espagne,' published in 1811, Humboldt described in a broad and philosophical way the great field of the Toluca Irons, and the size of some isolated masses in the States of Zacatecas and Durango. From that day until this naturalists and travelers in Mexico have examined and described this product of the country, commenting particularly upon their frequence and their size. Their frequence has been greatly overestimated. The total number credited to the Republic in Castillo's catalogue of 1889, was 27. To-day we know there are 32 distinct localities, omitting the several points embraced in two or three widespread showers.

Other areas of the same size as this Mexican belt in the United States and in India, give respectively 67 and 48 falls.

The preeminence of the Mexican meteorites is the vast size of many of them. In this matter of bulk they are unapproachable. Taking ten of the largest, we find their average weight to be 9 1/10 tons. This as against 8 1/3 cwt. as the average weight of the ten largest American meteorites.

The Mexican Government has taken an active and enlightened part in the protection of its meteorites. Twelve years ago it expended the sum of $10,000 in bringing five of the largest of these to the capital, where they are mounted on huge iron pillars in the entrance court of the School of Mines.

The largest Mexican iron and one of the two largest meteorites in the world is in the State of Sinaloa, far in the northwestern portion of the Republic. This was first brought to the notice of the scientific world by Señor Marino Barcena, the noted Mexican astronomer, in 1876. In a ten-line notice of it to the Philadelphia Academy of Science, he says, 'I can assure the Academy that its length is more than twelve feet.' Castillo repeats this reported measure, adding its breadth as 2 meters, and its thickness as 1.50 meters. Brezina, Cohen and Wülfing speak of it as weighing 50 tons and as being the largest meteorite in the world. But in all this there was no definite description of the mass, and no one who mentioned it claimed to have seen it. We were anxious to ascertain about all this, to find out the facts among many rumors. The Mexican savants were all interested in having this great celestial body investigated.

Through Señor José C. Aguilera, the Director of the Instituto Geologico, we obtained from the Minister of State letters to the Governor of Sinaloa and to the Director of Mines in that State. Western Sinaloa is practically impossible to reach in a direct line from the capital. The northern route through Arizona and Sonora involved a journey of over 2,000 miles. We took the shorter but harder route across the Cordilleras to the port of Manzanillo on the Pacific, and thence by steamer up the coast of the Gulf of California. There at the adjacent city of Culiacan we took a carriage with a four-mule team and an American photographer who accompanied us with his camera. A drive of 95 miles to the north and west took us in three days far up among the foothills of the Sierra Madre. Bacubirito is a small but very old mining town, situated on the road to Sinaloa in latitude 26°, and in west longitude 107°. The elevation above sea level is some 2,000 feet. The meteorite is seven miles nearly due south from there, near the hamlet called Palmar de la Sepulveda. Here we found it on a farm called Ranchito, which fills a narrow mountain valley between two spurs of the main range. It was there struck by the plow of Crescencio Aguilar in the summer of 1871. He soon uncovered enough of its bright surface to satisfy himself that he had found a silver mine! Its surrounding is now a cornfield with a black vegetable soil of some two yards in thickness. In this soil we found the great meteorite deeply imbedded. Its surface was but a little below the surface of the ground, but with one end slightly projecting above the level. It was a long, monstrous bowlder of black iron, which seemed to be still burrowing to hide itself from the upper world. Its surface form was something like that of a great ham. We could walk for many feet along and across its surface, surveying these dimensions, but knowing nothing of how far the mass penetrated the soil beneath. Our first work was excavation. We soon got twenty-eight able-bodied persons for this. We undertook an area of thirty feet on a side,

with the great meteorite lying within. In a single day we passed down through nearly four feet of the soft vegetable soil, and the meteorite began to show in its entirety. The general form of the mass seen from the side was that of one ramus of a huge jaw. The surface was entirely covered with 'pittings,' very regular in size, and about two to three inches across; shallow, but with well-defined walls. There were no areas which showed the devastation of deep rust; a fact due both to the dryness of the soil and to the large alloy of nickel in the iron. On one side there was a deep crack, running horizontally through half of the mass. At its inception this crack was too narrow to insert a knife blade; at the other end it was nearly three inches wide. Our Mexicans were astonished at the result of their own labors; they marveled alike at the size of the mass and at our credulity in believing that it had ever fallen from space above.

By the end of the second day we had carried our excavation to an average depth of six feet. Over the area the vegetable soil was from three to four feet deep, while below it was a porphyry rock, common in this part of the country, much broken up by natural cleavages and decomposed *in situ*. Immediately around the meteorite we had dug much lower, leaving the great iron mass poised on a pillar or pedestal of the undisturbed rock. Finally we performed a feat of moving the great block. To lift one end with heavy tackle or machinery would have been impossible for us; but it needed little mechanical aid to make the mass move itself. We attacked with our long iron bars one side of the supporting pedestal. After long chiseling away one side of this, the center of gravity was reached, and, with a slow, almost dignified, movement, the great meteorite sank at one end and assumed a partially vertical position. Looking beneath it, we found that its late bed was a clean depression crushed into the rock, with absolutely no soil between it and the mass which had lain above it. It would thus *seem* that the meteorite had fallen on the bare rock surface of this district at a period before the vegetable soil had begun to form here. This would be an interesting and astounding fact, carrying back the fall of our meteor to a remotely distant period, perhaps thousands of years. But there are other conditions which would need careful consideration before accepting so momentous a conclusion. The wonderful preservation of the mass, with its little oxidation, and the clean, sharp-rimmed pittings which cover its surface, seem to point to a more modern sojourn within the destroying influences of our air and moisture. We leave this for further consideration.

It is an interesting fact that this, perhaps the largest and heaviest meteorite yet discovered on our globe, should have fallen so near the present borders of our country. Interesting, too, that Mexico, with all its other extra large meteorites, should have received this champion mass. The extreme measures of Bacubirito, for so our meteorite from the first has been called, are:

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|---|---|---|---|---|
| Length | 13 | feet | and 1 | inch. |
| Width | 6 | " | " 2 | inches. |
| Thickness | 5 | " | " 4 | " |

The form of the mass is extremely irregular, and though measures have been taken around the mass at many different points, its cubic contents can not be calculated with more than an approximation to accuracy.

The five largest meteorites known to science to-day, are:

| | | |
|---|---|---|
| Bendego (Brazil) | 5 1/3 | tons. |
| San Gregorio (Mexico) | 11 1/2 | " |
| Chupaderos (Mexico) | 15 2/3 | " |
| Anighito (Greenland) | 50 | " |
| Bacubirito (Mexico) | 50 | " |

The first three are weights proven on scales. The latter two are thus far simple estimates. How far estimated weights, based generally on simple guessing, may differ from *proven* weights is well illustrated by the case of Chupaderos. Fletcher, the noted mineralogist of the British Museum, says of it, 'According to one recent estimate its weight is 15 tons, according to another it is 82 tons.' Anighito, the great Greenland meteorite, has been guessed at all figures from 30 to 100 tons. A late unofficial estimate of it, after careful measuring, puts its weight at 46 1/3 tons. Should the Mexican Government, as some

expect, move the great mass, as it has done all the others, to the capital, its exact weight will be finally and definitely known. Whichever meteorite shall, after accurate calculation, prove to be the heavier, it will ever remain of interest that the two largest meteorites known to our earth should have fallen on the North American Continent; one far toward its northern end, the other toward its southern.

HENRY A. WARD.

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## *SCIENTIFIC NOTES AND NEWS.*

LORD AVEBURY has been made a member of the Prussian order 'pour le merite.'

DR. WILHELM WUNDT, the eminent psychologist and philosopher, celebrated his seventieth birthday on August 16. A volume of researches carried out by his former students was presented to him on the occasion.

IT is announced from Berlin that the strength of Professor Virchow is unmistakably failing.

DR. EMIL TIETZE has been appointed director of the Imperial Geological Institute at Vienna.

AN international marine laboratory is to be established at Christiania under the directorship of Dr. Fridjof Nansen.

PROFESSOR ALBERT GAUDRY, the eminent paleontologist, has retired from his chair in the Paris Museum of Natural History, and has been made honorary professor.

A CABLE despatch to the daily papers from Samoa states that President David Starr Jordan was in serious danger owing to the capsizing of a boat, but was rescued by natives. He left for home on August 11. Dr. Vernon Lyman Kellogg, head of the department of entomology at Stanford University, who accompanied Dr. Jordan, has returned to the university.

ASTRONOMER WILLIAM H. WRIGHT, of the Lick Observatory, has been chosen to take charge of the D. O. Mills expedition, now being outfitted at Mount Hamilton, to spend two years in Chile in making special study of the stars of the Southern hemisphere. Director W. W. Campbell will go with the party to personally direct the erection of the observing station and the beginning of the two years' astronomical campaign. Mr. Harold K. Palmer, fellow in the Lick Observatory, will act as assistant.

A REPORT on the occurrence of copper in the vicinity of Clifton, in southern Arizona, is being prepared by Mr. W. Lindgren, of the U. S. Geological Survey.

ONE of the three Royal prizes of the Accademia dei Lincei, at Rome, has been awarded to Professor Cantone, of Pavia, for his researches in the phenomena of elastic equilibrium outside the limits of Hooke's Law. The ministerial prize for mathematics has been divided into two prizes of 1,300 lire, awarded to Professors Giuseppe Bagnera (Messina) and Domenico de Francesco (Naples), and a premium of 700 lire has been assigned to Professor Michele de Franchis (Melfi).

DR. MAX WOLF has been appointed director of the astrophysical department of the observatory at Heidelberg.

DR. WILLIAM OSLER, of Johns Hopkins University, will deliver a memorial address on 'William Beaumont, the first and greatest American Physiologist,' under the auspices of the St. Louis Medical Society on October 4.

THE Berlin Academy of Sciences has granted 15,000 Marks to Professor A. Voeltzkow for an expedition to East Africa.

ON the occasion of his retirement from the curatorship of the Royal Gardens at Kew, Mr. George Nicholson has been presented by his friends with a suitably inscribed salver.

THE topographic branch of the United States Geological Survey will continue this season the mapping of the forested regions of Washington in the Cascades, under the general oversight of Mr. Richard U. Goode, geographer.

PROFESSOR BARBOSA RODRIGUES, director of the Botanical Garden of Rio Janeiro, is at present in England.

DR. CADY STALEY, who has retired from the presidency of the Case School of Applied Science after sixteen years of service, has gone abroad, where he expects to remain for several years.

THE London board of trade has commissioned Lieutenant Colonel Horatio A. Yorke, chief inspecting officer of railways for the board of trade, to prepare a report on the workings of American railways. He will sail for New York on September 19.

THE centenary of the birth of the eminent mathematician, Abel, is being celebrated at Christiania this week.

A MONUMENT in memory of Cassini de Thury, the French astronomer, was unveiled at Clermont on July 27.

A BUST of the French naturalist, Ramond, known for his explorations in the Pyrenees, was unveiled at Bagnères-de-Bigorre on August 3.

THE Reverend Dr. Thomas Gallaudet, widely known for his work on behalf of the care of the deaf and dumb and until recently pastor of a church for deaf mutes, died on August 27, at the age of eighty years. Dr. Gallaudet's father, the Reverend Thomas Hopkins Gallaudet, founded the first permanent school for deaf mutes in 1817, and his brother, Dr. Edward Miner Gallaudet, has since 1864 been president of the Gallaudet College for the deaf at Washington.

THE death is announced of General A. Ferrero, of Rome, known for his contributions to geodesy and mathematics.

PROFESSOR A. N. BEKETOW, the Russian botanist, has died at the age of seventy-seven years. Dr. Johann Janko, director of the Ethnographical Division of the National Museum at Budapesth, has died at the age of thirty-four years.

THROUGH the will of the late John Dolbeer, of San Francisco, the Astronomical Society of the Pacific will receive the sum of five thousand dollars. Mr. Dolbeer had been a member of the Society since 1891 and was one of its past presidents. He took an active interest in astronomy and defrayed the expenses of the expedition sent out from the Chabot Observatory of Oakland, to Georgia, to observe the total solar eclipse of May 28, 1900. This is the second bequest to the society by deceased members. Mr. Marvin Reimer, of Chicago, left the sum of five hundred dollars. These funds will bear the names of the givers and will be invested. The income will be used by the society in diffusing astronomical knowledge.

AN exhibit to illustrate the state of education in the British Empire will be sent by the government to the St. Louis Exposition.

IT is stated in *Nature* that Messrs. Cook, the tourist agents, have put forward a proposal to run an electric railway to the crater of Vesuvius from the Naval Arsenal in Naples to take the place of the funicular railway now used. The faculty of science in the University of Naples has forwarded a strong protest against the scheme to the Italian government, on the grounds that it would interfere with the seismic and magnetic observations and records which are made at the university.

IN the House of Commons, as we learn from *Nature,* the decision to close the observatories at Ben Nevis and Fort William has been brought forward, and the first lord of the treasury was asked whether he would order an inquiry to be made into the distribution by the meteorological council of the annual grant of 15,300*l.*, so as to secure that an adequate allowance be made to these observatories. In his reply, Mr. Balfour referred to an inquiry held about twenty years ago, at the close of which the committee recommended that the inquiry should be repeated from time to time, a recommendation that has not been followed. In the circumstances he thought it would be right to have an investigation and to repeat it from time to time. This would involve no slight on the scientific committee which allocates the funds.

THE Baldwin-Ziegler Antarctic excursion can scarcely be regarded as a scientific expedition. We may, however, quote the following information, which Mr. Baldwin has given the Rueter's Agency: This year's work has been successful. An enormous depot of condensed foods has been established by sledge on Rudolf Land within sight of the Italian expedition's headquarters. A second depot has been formed in lat. 81° 33′, and a third depot at Kane Lodge, Greely Island, which has been newly charted

as near the 81st degree of latitude. These large depots, together with the houses and stores left at Camp Ziegler, as well as provisions for the five ponies and 150 good dogs now on board, besides the pack itself, will afford means for a large Polar dash party next year. The fact that all the channels through Franz Josef Land remained blocked by ice during the autumn of 1901 prevented the establishment of depots by steamer last year. The breaking up of the ice early in June compelled us to use our reserve supply of coal, and hence our departure from Camp Ziegler on July 1 in order not to imperil the expedition. We dispatched 15 balloons with 300 messages in June. We have obtained the first moving pictures of Arctic life. We discovered Nansen's hut, recovering the original document left there and securing paintings of the hut. We have also secured marine collections for the National Museum, new charts, etc. Thirty men, with 13 ponies, 170 dogs and 60 sledges, were employed in field work from January 21 to May 21, this severe work resulting in the destruction of the sledges; this and the depletion of the food for the ponies and the dogs rendered a return imperative.

THE water resources of the Great Plains will be the subject of continued investigation this summer by the United States Geological Survey. For the last two or three years Mr. N. H. Darton, of the Survey, has been engaged in tracing the source of the copious underground waters which appear in the wells of North Dakota and South Dakota. From careful studies of well borings and other geological phenomena of the region, it has been discovered that extensive water-bearing strata underlie the whole plains region and are bent upward and reach the surface on the eastern flanks of the Rocky and Bighorn Mountains and in the Black Hills uplift. This season Mr. Darton, assisted by Mr. C. A. Fisher, is engaged in continuing the survey of the water-bearing rocks in the Black Hills and Bighorn Mountains, and in a reconnaissance of the Great Plains for the preparation of a map showing the general geology and the location of the water-bearing beds of the whole region. The map will also indicate the distance at which the sandstones lie beneath the surface, and the probable depths of the wells necessary to reach them.

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## *UNIVERSITY AND EDUCATIONAL NEWS.*

THE will of the late Francis B. Loomis, of Cincinnati, has been sustained by the courts, and the Ohio Wesleyan University will receive $150,000.

DR. HOWARD A. KELLY, professor of gynecology in the Johns Hopkins University, has given $10,000 for an extension of the gynecological ward of the Johns Hopkins Hospital.

THE University of Nebraska has adopted a course of study in forestry, which will be open to students this year for the first time. It is four years in length, and the conditions for admission to the freshman year are the same as for admission to other university courses.

THE University of Nebraska Medical College will be opened this fall. It provides for two courses, one six years, and the other four years, in length, the first leading to the degrees B.Sc. and M.D., and the second to M.D. Entrance to these courses requires the work of four years in a good high school or academy.

A COURSE in practical physiology, commencing on October 10, 1902, is offered to public school teachers at the University and Bellevue Hospital Medical College (26th street and First avenue). The course includes much experimental work on nervous physiology which is of advantage for the comprehension of psychology. An exercise of two hours or more is given once a week for thirty weeks. The exercise commences at half past three on Fridays and may last until six o'clock. The students perform the experiments themselves. A short talk precedes each exercise and a conference over the results obtained follows the completion of the day's work. This course is one authorized for obtaining a degree in the graduate school of the New York University. It is identical with the course prescribed for second year medical school students. It will not be given to more than thirty applicants. The course is conducted by Professor Graham Lusk.